ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

R - 2013

B. E. PETROCHEMICAL ENGINEERING

PROGRAMME OBJECTIVES:

1. To produce employable graduates with the knowledge and competency in Petrochemical Engineering complemented by the appropriate skills and attributes.
2. To meet the world's ever-increasing demand for hydrocarbon fuel, thermal energy, and waste and pollution management.
3. To produce creative and innovative graduates with design and soft skills to carry out various problem solving tasks.
4. To enable the students to work as teams on multidisciplinary projects with effective communication skills, individual, supportive and leadership qualities with the right attitudes and ethics.
5. To produce graduates who possess interest in research and lifelong learning, as well as continuously striving for the forefront of technology.

PROGRAMME OUTCOMES:

The graduates of this programme would have

1. Ability to apply knowledge of mathematics, science, and engineering in core industry
2. Ability to design and conduct experiments, as well as to analyze and interpret data
3. Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
4. Ability to identify, formulate, and solve engineering problems related to petrochemical industry
5. Understanding of professional and ethical responsibility
6. Recognition of the need and ability to engage in life-long learning

ANNA UNIVERSITY, CHENNAI

AFFILIATED INSTITUTIONS

R - 2013

B. E. PETROCHEMICAL ENGINEERING

I – VIII SEMESTERS CURRICULUM AND SYLLABUS

SEMESTER - I

CODE	COURSE TITLE	L	T	P	C
THEORY					
HS6151	Technical English - I	3	1	0	4
MA6151	Mathematics – I	3	1	0	4
PH6151	Engineering Physics – I	3	0	0	3
CY6151	Engineering Chemistry – I	3	0	0	3
GE6151	Computer Programming	3	0	0	3
GE6152	Engineering Graphics	2	0	3	4
PRACTICAL					
GE6161	Computer Practices Laboratory	0	0	3	2
GE6162	Engineering Practices Laboratory	0	0	3	2
GE6163	Physics and Chemistry Laboratory - I	0	0	2	1
	TOTAL	**17**	**2**	**11**	**26**

SEMESTER – II

CODE	COURSE TITLE	L	T	P	C
THEORY					
HS6251	Technical English - II	3	1	0	4
MA6251	Mathematics - II	3	1	0	4
PH6251	Engineering Physics - II	3	0	0	3
CY6251	Engineering Chemistry - II	3	0	0	3
GE6252	Basic Electrical and Electronics Engineering	4	0	0	4
GE6253	Engineering Mechanics	3	1	0	4
PRACTICAL					
GE6261	Computer Aided Drafting and Modeling Laboratory	0	1	2	2
GE6262	Physics and Chemistry Laboratory - II	0	0	2	1
GE6263	Computer Programming Laboratory	0	1	2	2
		19	**5**	**6**	**27**

SEMESTER – III

CODE	COURSE TITLE	L	T	P	C
THEORY					
EL6302	Organic Chemistry	3	0	0	3
CH6404	Mechanical Operations	3	0	0	3
EE6351	Electrical Drives and Controls	3	0	0	3
MA6351	Transforms and Partial Differential Equations	3	1	0	4
CH6403	Chemical Process Calculations	3	0	0	3
CH6303	Physical Chemistry	3	0	0	3
PRACTICALS					
CH6311	Organic Chemistry Laboratory	0	0	3	2
EI6411	Electrical Machines Laboratory	0	0	3	2
PM6311	Machine Drawing	0	0	3	2
	TOTAL	**18**	**1**	**9**	**25**

SEMESTER – IV

CODE	COURSE TITLE	L	T	P	C
THEORY					
CE6402	Strength of Materials	3	1	0	4
PM6401	Fluid Mechanics	3	0	0	3
PC6501	Heat Transfer	3	1	0	4
MA6459	Numerical Methods	3	1	0	4
PC6301	Industrial Chemical Technology	3	0	0	3
PC6402	Engineering Thermodynamics	3	1	0	4
PRACTICALS					
CH6413	Physical Chemistry Laboratory	0	0	4	2
PM6412	Mechanical Operations Laboratory	0	0	3	2
PM6411	Fluid Mechanics Laboratory	0	0	3	2
	TOTAL	**18**	**4**	**10**	**28**

SEMESTER – V

CODE	COURSE TITLE	L	T	P	C
THEORY					
GE6351	Environmental Science and Engineering	3	0	0	3
PM6501	Mass Transfer I	3	1	0	4
PC6503	Petroleum Exploration and Exploitation Techniques	3	0	0	3
PM6502	Chemical Reaction Engineering	3	1	0	4
PE6606	Natural Gas Engineering	3	1	0	4
PC6401	Materials Technology	3	0	0	3
PRACTICALS					
CH6611	Heat Transfer Laboratory	0	0	3	2
CH6411	Technical Analysis Laboratory	0	0	3	2
GE6674	Communication and Soft Skills - Laboratory Based	0	0	4	2
	TOTAL	**18**	**3**	**10**	**27**

SEMESTER – VI

CODE	COURSE TITLE	L	T	P	C
THEORY					
PM6601	Mass Transfer II	3	1	0	4
EL6605	Process Dynamics and Control	3	1	0	4
PM6603	Equipment Design and Drawing-I	2	0	2	3
PC6606	Petroleum Crude Processing Technology	3	0	0	3
PM6604	Water Treatment and Management	3	0	0	3
PM6605	Instrumentation and Instrumental Analysis	3	0	0	3
PRACTICALS					
PM6611	Mass Transfer Laboratory	0	0	3	2
PM6612	Petroleum Physical Properties Testing Laboratory	0	0	3	2
PC6712	Chemical Reaction Engineering Laboratory	0	0	3	2
	TOTAL	**17**	**2**	**11**	**26**

SEMESTER – VII

CODE	COURSE TITLE	L	T	P	C
THEORY					
CH6702	Transport Phenomena	3	0	0	3
PM6701	Equipment Design and Drawing-II	2	0	2	4
PM6702	Petroleum Secondary Processing Technology	3	0	0	3
PM6703	Petrochemical Unit Processes	3	0	0	3
PM6704	Refinery Process Design	3	0	0	3
	Elective – I	3	0	0	3
PRACTICALS					
EL6713	Process Dynamics and Control Laboratory	0	0	3	2
PM6711	Petrochemical Analysis Laboratory	0	0	3	2
PC6711	Petroleum Product Testing Laboratory	0	0	3	2
	TOTAL	**17**	**0**	**11**	**25**

SEMESTER – VIII

CODE	COURSE TITLE	L	T	P	C
THEORY					
PM6801	Process Engineering Economics	3	0	0	3
PM6802	Safety and Risk Management	3	0	0	3
	Elective -II	3	0	0	3
PRACTICALS					
PM6811	Project Work*	0	0	12	6
	TOTAL	**9**	**0**	**12**	**15**

TOTAL NO OF CREDITS: 199

LIST OF ELECTIVES

B. E. PETROCHEMICAL ENGINEERING

VII SEMESTER

CODE	COURSE TITLE	L	T	P	C
CH6016	Process Modelling and Simulation	3	0	0	3
CH6009	Fertilizer Technology	3	0	0	3
PC6002	Petroleum Process Equipment Auxiliaries	3	0	0	3
MG6091	Industrial management	3	0	0	3
GE6757	Total Quality Management	3	0	0	3

VIII SEMESTER

CODE	COURSE TITLE	L	T	P	C
CH6002	Fluidization Engineering	3	0	0	3
PC6005	Energy Management in Chemical Industries	3	0	0	3
PC6004	Novel Separation Processes	3	0	0	3
PC6006	Multicomponent Distillation	3	0	0	3
PC6008	Polymer Technology	3	0	0	3

HS6151 **TECHNICAL ENGLISH – I** **L T P C**
3 1 0 4

OBJECTIVES:

- To enable learners of Engineering and Technology develop their basic communication skills in English.
- To emphasize specially the development of speaking skills amongst learners of Engineering and Technology.
- To ensure that learners use the electronic media such as internet and supplement the learning materials used in the classroom.
- To inculcate the habit of reading and writing leading to effective and efficient communication.

UNIT I **9+3**

Listening - Introducing learners to GIE - Types of listening - Listening to audio (verbal & sounds); Speaking - Speaking about one's place, important festivals etc. – Introducing oneself, one's family / friend; Reading - Skimming a reading passage – Scanning for specific information - Note-making; Writing - Free writing on any given topic (My favourite place / Hobbies / School life, etc.) - Sentence completion - Autobiographical writing (writing about one's leisure time activities, hometown, etc.); Grammar - Prepositions - Reference words - Wh-questions - Tenses (Simple); Vocabulary - Word formation - Word expansion (root words / etymology); E-materials - Interactive exercises for Grammar & Vocabulary - Reading comprehension exercises - Listening to audio files and answering questions.

UNIT II **9+3**

Listening - Listening and responding to video lectures / talks; Speaking - Describing a simple process (filling a form, etc.) - Asking and answering questions - Telephone skills – Telephone etiquette; Reading – Critical reading - Finding key information in a given text - Sifting facts from opinions; Writing - Biographical writing (place, people) - Process descriptions (general/specific) - Definitions - Recommendations – Instructions; Grammar - Use of imperatives - Subject-verb agreement; Vocabulary - Compound words - Word Association (connotation); E-materials - Interactive exercises for Grammar and Vocabulary - Listening exercises with sample telephone conversations / lectures – Picture-based activities.

UNIT III **9+3**

Listening - Listening to specific task - focused audio tracks; Speaking - Role-play – Simulation - Group interaction - Speaking in formal situations (teachers, officials, foreigners); Reading - Reading and interpreting visual material; Writing - Jumbled sentences - Coherence and cohesion in writing - Channel conversion (flowchart into process) - Types of paragraph (cause and effect / compare and contrast / narrative / analytical) - Informal writing (letter/e-mail/blogs) - Paraphrasing; Grammar - Tenses (Past) - Use of sequence words - Adjectives; Vocabulary - Different forms and uses of words, Cause and effect words; E-materials - Interactive exercises for Grammar and Vocabulary - Excerpts from films related to the theme and follow up exercises - Pictures of flow charts and tables for interpretations.

UNIT IV **9+3**

Listening - Watching videos / documentaries and responding to questions based on them; Speaking - Responding to questions - Different forms of interviews - Speaking at different types of interviews; Reading - Making inference from the reading passage - Predicting the content of a reading passage; Writing - Interpreting visual materials (line graphs, pie charts etc.) - Essay writing – Different types of essays; Grammar - Adverbs – Tenses – future time reference; Vocabulary - Single word substitutes - Use of abbreviations and acronyms; E-materials - Interactive exercises for Grammar and Vocabulary - Sample interviews - film scenes - dialogue writing.

UNIT V **9+3**

Listening - Listening to different accents, Listening to Speeches/Presentations, Listening to broadcast and telecast from Radio and TV; Speaking - Giving impromptu talks, Making presentations on given topics; Reading - Email communication - Reading the attachment files having a poem/joke/proverb - Sending their responses through email; Writing - Creative writing, Poster making; Grammar - Direct and indirect speech; Vocabulary - Lexical items (fixed / semi fixed expressions); E-materials - Interactive exercises for Grammar and Vocabulary - Sending emails with attachment – Audio / video excerpts of different accents - Interpreting posters.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

Learners should be able to

- speak clearly, confidently, comprehensibly, and communicate with one or many listeners using appropriate communicative strategies.
- write cohesively and coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on a topic.
- read different genres of texts adopting various reading strategies.
- listen/view and comprehend different spoken discourses/excerpts in different accents

TEXTBOOKS:

1. Department of English, Anna University. Mindscapes: English for Technologists and Engineers. Orient Blackswan, Chennai. 2012
2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai. 2011

REFERENCES:

1. Raman, Meenakshi & Sangeetha Sharma. Technical Communication: Principles and Practice. Oxford University Press, New Delhi. 2011.
2. Regional Institute of English. English for Engineers. Cambridge University Press, New Delhi. 2006.
3. Rizvi, Ashraf. M. Effective Technical Communication. Tata McGraw-Hill, New Delhi. 2005
4. Rutherford, Andrea. J Basic Communication Skills for Technology. Pearson, New Delhi. 2001.
5. Viswamohan, Aysha. English for Technical Communication. Tata McGraw-Hill, New Delhi. 2008.

EXTENSIVE Reading (Not for Examination)

1. Kalam, Abdul. Wings of Fire. Universities Press, Hyderabad. 1999.

WEBSITES:

1. http://www.usingenglish.com
2. http://www.uefap.com

TEACHING METHODS:

- Lectures
- Activities conducted individually, in pairs and in groups like self introduction, peer introduction, group poster making, grammar and vocabulary games, etc.
- Discussions
- Role play activities
- Short presentations
- Listening and viewing activities with follow up activities like discussion, filling up worksheets, writing exercises (using language lab wherever necessary/possible) etc.

EVALUATION PATTERN:

Internal assessment: 20%

3 tests of which two are pen and paper tests and the other is a combination of different modes of assessment like

- Project
- Assignment
- Reviews
- Creative writing
- Poster making, etc.

All the four skills are to be tested with equal weightage given to each.

- ✓ Speaking assessment: Individual speaking activities, Pair work activities like role play, Interview, Group discussions
- ✓ Reading assessment: Reading passages with comprehension questions graded from simple to complex, from direct to inferential
- ✓ Writing assessment: Writing paragraphs, essays etc. Writing should include grammar and vocabulary.
- ✓ Listening/Viewing assessment: Lectures, dialogues, film clippings with questions on verbal as well as audio/visual content.

End Semester Examination: 80%

MA6151	**MATHEMATICS – I**	**L T P C**
		3 1 0 4

OBJECTIVES:

- To develop the use of matrix algebra techniques this is needed by engineers for practical applications.
- To make the student knowledgeable in the area of infinite series and their convergence so that he/ she will be familiar with limitations of using infinite series approximations for solutions arising in mathematical modeling.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To introduce the concepts of improper integrals, Gamma, Beta and Error functions which are needed in engineering applications.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

UNIT I MATRICES 9+3

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of eigenvalues and eigenvectors – Statement and applications of Cayley-Hamilton Theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II SEQUENCES AND SERIES 9+3

Sequences: Definition and examples – Series: Types and Convergence – Series of positive terms – Tests of convergence: Comparison test, Integral test and D'Alembert's ratio test –

Alternating series – Leibnitz's test – Series of positive and negative terms – Absolute and conditional convergence.

UNIT III APPLICATIONS OF DIFFERENTIAL CALCULUS 9+3

Curvature in Cartesian co-ordinates – Centre and radius of curvature – Circle of curvature – Evolutes – Envelopes - Evolute as envelope of normals.

UNIT IV DIFFERENTIAL CALCULUS OF SEVERAL VARIABLES 9+3

Limits and Continuity – Partial derivatives – Total derivative – Differentiation of implicit functions – Jacobian and properties – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT V MULTIPLE INTEGRALS 9+3

Double integrals in cartesian and polar coordinates – Change of order of integration – Area enclosed by plane curves – Change of variables in double integrals – Area of a curved surface - Triple integrals – Volume of Solids.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- This course equips students to have basic knowledge and understanding in one fields of materials, integral and differential calculus.

TEXT BOOKS:

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
2. Grewal. B.S, "Higher Engineering Mathematics", 41st Edition, Khanna Publications, Delhi, 2011.

REFERENCES:

1. Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S. Chand Private Ltd., 2011.
2. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2012.
3. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.
4. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2008.
5. Sivarama Krishna Das P. and Rukmangadachari E., "Engineering Mathematics", Volume I, Second Edition, PEARSON Publishing, 2011.

PH6151 ENGINEERING PHYSICS – I L T P C

3 0 0 3

OBJECTIVES:

- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT I CRYSTAL PHYSICS 9

Lattice – Unit cell – Bravais lattice – Lattice planes – Miller indices – d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC and HCP structures – Diamond and graphite structures (qualitative

treatment) - Crystal growth techniques –solution, melt (Bridgman and Czochralski) and vapour growth techniques (qualitative)

UNIT II PROPERTIES OF MATTER AND THERMAL PHYSICS 9

Elasticity- Hooke's law - Relationship between three modulii of elasticity (qualitative) – stress - strain diagram – Poisson's ratio –Factors affecting elasticity –Bending moment – Depression of a cantilever –Young's modulus by uniform bending- I-shaped girders

Modes of heat transfer- thermal conductivity- Newton's law of cooling - Linear heat flow – Lee's disc method – Radial heat flow – Rubber tube method – conduction through compound media (series and parallel)

UNIT III QUANTUM PHYSICS 9

Black body radiation – Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jeans' Law from Planck's theory – Compton effect. Theory and experimental verification – Properties of Matter waves – G.P Thomson experiment -Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box - Electron microscope - Scanning electron microscope - Transmission electron microscope.

UNIT IV ACOUSTICS AND ULTRASONICS 9

Classification of Sound- decibel- Weber–Fechner law – Sabine's formula- derivation using growth and decay method – Absorption Coefficient and its determination –factors affecting acoustics of buildings and their remedies.

Production of ultrasonics by magnetostriction and piezoelectric methods - acoustic grating - Non Destructive Testing – pulse echo system through transmission and reflection modes - A,B and C –scan displays, Medical applications - Sonogram

UNIT V PHOTONICS AND FIBRE OPTICS 9

Spontaneous and stimulated emission- Population inversion -Einstein's A and B coefficients - derivation. Types of lasers – Nd:YAG, CO_2, Semiconductor lasers (homojunction & heterojunction)- Industrial and Medical Applications.

Principle and propagation of light in optical fibres – Numerical aperture and Acceptance angle - Types of optical fibres (material, refractive index, mode) – attenuation, dispersion, bending - Fibre Optical Communication system (Block diagram) - Active and passive fibre sensors- Endoscope.

TOTAL: 45 PERIODS

OUTCOMES:

- The students will have knowledge on the basics of physics related to properties of matter, optics, acoustics etc., and they will apply these fundamental principles to solve practical problems related to materials used for engineering applications.

TEXT BOOKS:

1. Arumugam M. Engineering Physics. Anuradha publishers, 2010
2. Gaur R.K. and Gupta S.L. Engineering Physics. Dhanpat Rai publishers, 2009
3. Mani Naidu S. Engineering Physics, Second Edition, PEARSON Publishing, 2011.

REFERENCES:

1. Searls and Zemansky. University Physics, 2009
2. Mani P. Engineering Physics I. Dhanam Publications, 2011
3. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009
4. Palanisamy P.K. Engineering Physics. SCITECH Publications, 2011
5. Rajagopal K. Engineering Physics. PHI, New Delhi, 2011
6. Senthilkumar G. Engineering Physics I. VRB Publishers, 2011.

CY6151 **ENGINEERING CHEMISTRY - I** **L T P C**
3 0 0 3

OBJECTIVES:

- To make the students conversant with basics of polymer chemistry.
- To make the student acquire sound knowledge of second law of thermodynamics and second law based derivations of importance in engineering applications in all disciplines.
- To acquaint the student with concepts of important photophysical and photochemical processes and spectroscopy.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- To acquaint the students with the basics of nano materials, their properties and applications.

UNIT I POLYMER CHEMISTRY 9

Introduction: Classification of polymers – Natural and synthetic; Thermoplastic and Thermosetting. Functionality – Degree of polymerization. Types and mechanism of polymerization: Addition (Free Radical, cationic and anionic); condensation and copolymerization. Properties of polymers: Tg, Tacticity, Molecular weight – weight average, number average and polydispersity index. Techniques of polymerization: Bulk, emulsion, solution and suspension. Preparation, properties and uses of Nylon 6,6, and Epoxy resin.

UNIT II CHEMICAL THERMODYNAMICS 9

Terminology of thermodynamics - Second law: Entropy - entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions; Clausius inequality. Free energy and work function: Helmholtz and Gibbs free energy functions (problems); Criteria of spontaneity; Gibbs-Helmholtz equation (problems); Clausius-Clapeyron equation; Maxwell relations – Van't Hoff isotherm and isochore(problems).

UNIT III PHOTOCHEMISTRY AND SPECTROSCOPY 9

Photochemistry: Laws of photochemistry - Grotthuss–Draper law, Stark–Einstein law and Lambert-Beer Law. Quantum efficiency – determination- Photo processes - Internal Conversion, Inter-system crossing, Fluorescence, Phosphorescence, Chemiluminescence and Photo-sensitization. Spectroscopy: Electromagnetic spectrum - Absorption of radiation – Electronic, Vibrational and rotational transitions. UV-visible and IR spectroscopy – principles, instrumentation (Block diagram only).

UNIT IV PHASE RULE AND ALLOYS 9

Phase rule: Introduction, definition of terms with examples, One Component System- water system - Reduced phase rule - Two Component Systems- classification – lead-silver system, zinc-magnesium system. Alloys: Introduction- Definition- Properties of alloys- Significance of alloying, Functions and effect of alloying elements- Ferrous alloys- Nichrome and Stainless steel – heat treatment of steel; Non-ferrous alloys – brass and bronze.

UNIT V NANOCHEMISTRY 9

Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Nanoparticles: nano cluster, nano rod, nanotube(CNT) and nanowire. Synthesis: precipitation, thermolysis, hydrothermal, solvothermal, electrode position, chemical vapour deposition, laser ablation; Properties and applications

TOTAL :45 PERIODS

OUTCOMES:

- The knowledge gained on polymer chemistry, thermodynamics. spectroscopy, phase rule and nano materials will provide a strong platform to understand the concepts on these subjects for further learning.

TEXT BOOKS:

1. Jain P.C. and Monica Jain, “Engineering Chemistry”, Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 2010
2. Kannan P., Ravikrishnan A., “Engineering Chemistry”, Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2009

REFERENCES:

1. Dara S.S, Umare S.S, “Engineering Chemistry”, S. Chand & Company Ltd., New Delhi 2010
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company, Ltd., New Delhi, 2008.
3. Gowariker V.R. , Viswanathan N.V. and JayadevSreedhar, “Polymer Science”, New Age International P (Ltd.,), Chennai, 2006.
4. Ozin G. A. and Arsenault A. C., “Nanochemistry: A Chemical Approach to Nanomaterials”, RSC Publishing, 2005.

GE6151 COMPUTER PROGRAMMING L T P C

3 0 0 3

OBJECTIVES:

The students should be made to:

- Learn the organization of a digital computer.
- Be exposed to the number systems.
- Learn to think logically and write pseudo code or draw flow charts for problems.
- Be exposed to the syntax of C.
- Be familiar with programming in C.
- Learn to use arrays, strings, functions, pointers, structures and unions in C.

UNIT I INTRODUCTION 8

Generation and Classification of Computers- Basic Organization of a Computer –Number System – Binary – Decimal – Conversion – Problems. Need for logical analysis and thinking – Algorithm – Pseudo code – Flow Chart.

UNIT II C PROGRAMMING BASICS 10

Problem formulation – Problem Solving - Introduction to ‘ C’ programming –fundamentals – structure of a ‘C’ program – compilation and linking processes – Constants, Variables – Data Types – Expressions using operators in ‘C’ – Managing Input and Output operations – Decision Making and Branching – Looping statements – solving simple scientific and statistical problems.

UNIT III ARRAYS AND STRINGS 9

Arrays – Initialization – Declaration – One dimensional and Two dimensional arrays. String- String operations – String Arrays. Simple programs- sorting- searching – matrix operations.

UNIT IV FUNCTIONS AND POINTERS 9

Function – definition of function – Declaration of function – Pass by value – Pass by reference – Recursion – Pointers - Definition – Initialization – Pointers arithmetic – Pointers and arrays- Example Problems.

UNIT V STRUCTURES AND UNIONS 9

Introduction – need for structure data type – structure definition – Structure declaration – Structure within a structure - Union - Programs using structures and Unions – Storage classes, Pre-processor directives.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Design C Programs for problems.
- Write and execute C programs for simple applications.

TEXTBOOKS:

1. Anita Goel and Ajay Mittal, "Computer Fundamentals and Programming in C", Dorling Kindersley (India) Pvt. Ltd., Pearson Education in South Asia, 2011.
2. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", First Edition, Oxford University Press, 2009
3. Yashavant P. Kanetkar. " Let Us C", BPB Publications, 2011.

REFERENCES:

1. Byron S Gottfried, "Programming with C", Schaum's Outlines, Second Edition, Tata McGraw-Hill, 2006.
2. Dromey R.G., "How to Solve it by Computer", Pearson Education, Fourth Reprint, 2007.
3. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006.
4. Dr. M. Rajaram and P. Uma Maheswari, "Computer Programming with C", Pearson, 2014.

GE6152 ENGINEERING GRAPHICS L T P C
2 0 3 4

OBJECTIVES:

- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREE HAND SKETCHING 5+9

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves, Scales: Construction of Diagonal and Vernier scales.

Visualization concepts and Free Hand sketching: Visualization principles –Representation of

Three Dimensional objects – Layout of views- Free hand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES 5+9

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS 5+9

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method and auxiliary plane method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5+9

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids – Prisms, pyramids cylinders and cones. Development of lateral surfaces of solids with cut-outs and holes

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+9

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions and miscellaneous problems. Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method .

COMPUTER AIDED DRAFTING (Demonstration Only) 3

Introduction to drafting packages and demonstration of their use.

TOTAL : 75 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

- perform free hand sketching of basic geometrical constructions and multiple views of objects.
- do orthographic projection of lines and plane surfaces.
- draw projections and solids and development of surfaces.
- prepare isometric and perspective sections of simple solids.
- demonstrate computer aided drafting.

TEXT BOOK:

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.

REFERENCES:

1. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
2. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
3. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 2nd Edition, 2009.
4. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008.
5. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2009.
6. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

GE6161 COMPUTER PRACTICES LABORATORY L T P C
0 0 3 2

OBJECTIVES:

The student should be made to:

- Be familiar with the use of Office software.
- Be exposed to presentation and visualization tools.
- Be exposed to problem solving techniques and flow charts.
- Be familiar with programming in C.
- Learn to use Arrays, strings, functions, structures and unions.

LIST OF EXPERIMENTS:

1. Search, generate, manipulate data using MS office/ Open Office
2. Presentation and Visualization – graphs, charts, 2D, 3D
3. Problem formulation, Problem Solving and Flowcharts
4. C Programming using Simple statements and expressions
5. Scientific problem solving using decision making and looping.
6. Simple programming for one dimensional and two dimensional arrays.
7. Solving problems using String functions
8. Programs with user defined functions – Includes Parameter Passing
9. Program using Recursive Function and conversion from given program to flow chart.
10. Program using structures and unions.

TOTAL : 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Apply good programming design methods for program development.
- Design and implement C programs for simple applications.
- Develop recursive programs.

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS:

Standalone desktops with C compiler 30 Nos.

(or)

Server with C compiler supporting 30 terminals or more.

GE6162 ENGINEERING PRACTICES LABORATORY L T P C
0 0 3 2

OBJECTIVES:

- To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE 9

Buildings:

(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
(b) Study of pipe connections requirements for pumps and turbines.
(c) Preparation of plumbing line sketches for water supply and sewage works.
(d) Hands-on-exercise:

Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.

(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:

(a) Study of the joints in roofs, doors, windows and furniture.
(b) Hands-on-exercise:

Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE 13

Welding:

(a) Preparation of arc welding of butt joints, lap joints and tee joints.
(b) Gas welding practice

Basic Machining:

(a) Simple Turning and Taper turning
(b) Drilling Practice

Sheet Metal Work:

(a) Forming & Bending:
(b) Model making – Trays, funnels, etc.
(c) Different type of joints.

Machine assembly practice:

(a) Study of centrifugal pump

(b) Study of air conditioner

Demonstration on:

(a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.
(b) Foundry operations like mould preparation for gear and step cone pulley.
(c) Fitting – Exercises – Preparation of square fitting and vee – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE 10

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

IV ELECTRONICS ENGINEERING PRACTICE 13

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EOR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits – Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL: 45 PERIODS

OUTCOMES:

- ability to fabricate carpentry components and pipe connections including plumbing works.
- ability to use welding equipments to join the structures.
- ability to fabricate electrical and electronics circuits.

REFERENCES:

1. Jeyachandran K., Natarajan S. & Balasubramanian S., “A Primer on Engineering Practices Laboratory”, Anuradha Publications, 2007.
2. Jeyapoovan T., Saravanapandian M. & Pranitha S., “Engineering Practices Lab Manual”, Vikas Puplishing House Pvt.Ltd, 2006.
3. Bawa H.S., “Workshop Practice”, Tata McGraw – Hill Publishing Company Limited, 2007.
4. Rajendra Prasad A. & Sarma P.M.M.S., “Workshop Practice”, Sree Sai Publication, 2002.
5. Kannaiah P. & Narayana K.L., “Manual on Workshop Practice”, Scitech Publications, 1999.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. 15 Sets.
2. Carpentry vice (fitted to work bench) 15 Nos.

3. Standard woodworking tools	15 Sets.
4. Models of industrial trusses, door joints, furniture joints	5 each
5. Power Tools: (a) Rotary Hammer	2 Nos
(b) Demolition Hammer	2 Nos
(c) Circular Saw	2 Nos
(d) Planer	2 Nos
(e) Hand Drilling Machine	2 Nos
(f) Jigsaw	2 Nos

MECHANICAL

1. Arc welding transformer with cables and holders	5 Nos.
2. Welding booth with exhaust facility	5 Nos.
3. Welding accessories like welding shield, chipping hammer, wire brush, etc.	5 Sets.
4. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit.	2 Nos.
5. Centre lathe	2 Nos.
6. Hearth furnace, anvil and smithy tools	2 Sets.
7. Moulding table, foundry tools	2 Sets.
8. Power Tool: Angle Grinder	2 Nos
9. Study-purpose items: centrifugal pump, air-conditioner	One each.

ELECTRICAL

1. Assorted electrical components for house wiring	15 Sets
2. Electrical measuring instruments	10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp	1 each
4. Megger (250V/500V)	1 No.
5. Power Tools: (a) Range Finder	2 Nos
(b) Digital Live-wire detector	2 Nos

ELECTRONICS

1. Soldering guns	10 Nos.
2. Assorted electronic components for making circuits	50 Nos.
3. Small PCBs	10 Nos.
4. Multimeters	10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply	

GE6163 PHYSICS AND CHEMISTRY LABORATORY – I L T P C
0 0 2 1

PHYSICS LABORATORY – I

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics and properties of matter.

LIST OF EXPERIMENTS

(Any FIVE Experiments)

1. (a) Determination of Wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fiber.
2. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer.
3. Determination of wavelength of mercury spectrum – spectrometer grating
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of Young's modulus by Non uniform bending method
6. Determination of specific resistance of a given coil of wire – Carey Foster's Bridge

OUTCOMES:

- The hands on exercises undergone by the students will help them to apply physics principles of optics and thermal physics to evaluate engineering properties of materials.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Diode laser, lycopodium powder, glass plate, optical fiber.
2. Ultrasonic interferometer
3. Spectrometer, mercury lamp, grating
4. Lee's Disc experimental set up
5. Traveling microscope, meter scale, knife edge, weights
6. Carey foster's bridge set up
   (vernier Caliper, Screw gauge, reading lens are required for most of the experiments)

CHEMISTRY LABORATORY- I

OBJECTIVES:

- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by vacometry.

LIST OF EXPERIMENTS

(Any FIVE Experiments)

1 Determination of DO content of water sample by Winkler's method.
2 Determination of chloride content of water sample by argentometric method.
3 Determination of strength of given hydrochloric acid using pH meter.
4 Determination of strength of acids in a mixture using conductivity meter.
5 Estimation of iron content of the water sample using spectrophotometer. (1,10- phenanthroline / thiocyanate method).
6 Determination of molecular weight of polyvinylalcohol using Ostwald viscometer.
7 Conductometric titration of strong acid vs strong base.

TOTAL: 30 PERIODS

OUTCOMES:

- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

REFERENCES:

1. Daniel R. Palleros, "Experimental organic chemistry" John Wiley & Sons, Inc., New York 2001.
2. Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., "Vogel's Textbook of practical organic chemistry", LBS Singapore 1994.

3. Jeffery G.H., Bassett J., Mendham J.and Denny vogel's R.C, "Text book of quantitative analysis chemical analysis", ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.
4. Kolthoff I.M., Sandell E.B. et al. "Quantitative chemical analysis", Mcmillan, Madras 1980.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Iodine flask	-	30 Nos
2.	pH meter	-	5 Nos
3.	Conductivity meter	-	5 Nos
4.	Spectrophotometer	-	5 Nos
5.	Ostwald Viscometer	-	10 Nos

Common Apparatus : Pipette, Burette, conical flask, percelain tile, dropper (each 30 Nos.)

HS6251 TECHNICAL ENGLISH II L T P C
3 1 0 4

OBJECTIVES:

- To make learners acquire listening and speaking skills in both formal and informal contexts.
- To help them develop their reading skills by familiarizing them with different types of reading strategies.
- To equip them with writing skills needed for academic as well as workplace contexts.
- To make them acquire language skills at their own pace by using e-materials and language lab components.

UNIT I 9+3

Listening - Listening to informal conversations and participating; Speaking - Opening a conversation (greetings, comments on topics like weather) - Turn taking - Closing a conversation (excuses, general wish, positive comment, thanks); Reading - Developing analytical skills, Deductive and inductive reasoning - Extensive reading; Writing - Effective use of SMS for sending short notes and messages - Using 'emoticons' as symbols in email messages; Grammar - Regular and irregular verbs - Active and passive voice; Vocabulary - Homonyms (e.g. 'can') - Homophones (e.g. 'some', 'sum'); E-materials - Interactive exercise on Grammar and vocabulary – blogging; Language Lab - Listening to different types of conversation and answering questions.

UNIT II 9+3

Listening - Listening to situation based dialogues; Speaking - Conversation practice in real life situations, asking for directions (using polite expressions), giving directions (using imperative sentences), Purchasing goods from a shop, Discussing various aspects of a film (they have already seen) or a book (they have already read); Reading - Reading a short story or an article from newspaper, Critical reading, Comprehension skills; Writing - Writing a review / summary of a story / article, Personal letter (Inviting your friend to a function, congratulating someone for his / her success, thanking one's friends / relatives); Grammar - modal verbs, Purpose expressions; Vocabulary - Phrasal verbs and their meanings, Using phrasal verbs in sentences; E-materials - Interactive exercises on Grammar and vocabulary, Extensive reading activity (reading stories / novels), Posting reviews in blogs - Language Lab - Dialogues (Fill up exercises), Recording students' dialogues.

UNIT III **9+3**

Listening - Listening to the conversation - Understanding the structure of conversations; Speaking - Conversation skills with a sense of stress, intonation, pronunciation and meaning - Seeking information – expressing feelings (affection, anger, regret, etc.); Reading - Speed reading – reading passages with time limit - Skimming; Writing - Minutes of meeting – format and practice in the preparation of minutes - Writing summary after reading articles from journals - Format for journal articles – elements of technical articles (abstract, introduction, methodology, results, discussion, conclusion, appendices, references) - Writing strategies; Grammar - Conditional clauses - Cause and effect expressions; Vocabulary - Words used as nouns and verbs without any change in the spelling (e.g. 'rock', 'train', 'ring'); E-materials - Interactive exercise on Grammar and vocabulary - Speed Reading practice exercises; Language Lab - Intonation practice using EFLU and RIE materials – Attending a meeting and writing minutes.

UNIT IV **9+3**

Listening - Listening to a telephone conversation, Viewing model interviews (face-to-face, telephonic and video conferencing); Speaking - Role play practice in telephone skills - listening and responding, -asking questions, -note taking – passing on messages, Role play and mock interview for grasping interview skills; Reading - Reading the job advertisements and the profile of the company concerned – scanning; Writing - Applying for a job – cover letter - résumé preparation – vision, mission and goals of the candidate; Grammar - Numerical expressions - Connectives (discourse markers); Vocabulary - Idioms and their meanings – using idioms in sentences; E-materials - Interactive exercises on Grammar and Vocabulary - Different forms of résumés- Filling up a résumé / cover letter; Language Lab - Telephonic interview – recording the responses - e-résumé writing.

UNIT V **9+3**

Listening - Viewing a model group discussion and reviewing the performance of each participant - Identifying the characteristics of a good listener; Speaking - Group discussion skills – initiating the discussion – exchanging suggestions and proposals – expressing dissent/agreement – assertiveness in expressing opinions – mind mapping technique; Reading - Note making skills – making notes from books, or any form of written materials - Intensive reading; Writing – Checklist - Types of reports – Feasibility / Project report – report format – recommendations / suggestions – interpretation of data (using charts for effective presentation); Grammar - Use of clauses; Vocabulary – Collocation; E-materials - Interactive grammar and vocabulary exercises - Sample GD - Pictures for discussion, Interactive grammar and vocabulary exercises; Language Lab - Different models of group discussion.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

Learners should be able to

- speak convincingly, express their opinions clearly, initiate a discussion, negotiate, argue using appropriate communicative strategies.
- write effectively and persuasively and produce different types of writing such as narration, description, exposition and argument as well as creative, critical, analytical and evaluative writing.
- read different genres of texts, infer implied meanings and critically analyse and evaluate them for ideas as well as for method of presentation.
- listen/view and comprehend different spoken excerpts critically and infer unspoken and implied meanings.

TEXTBOOKS:

1. Department of English, Anna University. Mindscapes: English for Technologists and Engineers. Orient Blackswan, Chennai. 2012

2. Dhanavel, S.P. English and Communication Skills for Students of Science and Engineering. Orient Blackswan, Chennai. 2011

REFERENCES:

1. Anderson, Paul V. Technical Communication: A Reader-Centered Approach. Cengage. New Delhi. 2008
2. Muralikrishna, & Sunita Mishra. Communication Skills for Engineers. Pearson, New Delhi. 2011
3. Riordan, Daniel. G. Technical Communication. Cengage Learning, New Delhi. 2005
4. Sharma, Sangeetha & Binod Mishra. Communication Skills for Engineers and Scientists. PHI Learning, New Delhi. 2009
5. Smith-Worthington, Darlene & Sue Jefferson. Technical Writing for Success. Cengage, Mason USA. 2007

EXTENSIVE Reading (Not for Examination)

1. Khera, Shiv. You can Win. Macmillan, Delhi. 1998.

Websites

1. http://www.englishclub.com
2. http://owl.english.purdue.edu

TEACHING METHODS:

- Lectures
- Activities conducted individually, in pairs and in groups like individual writing and presentations, group discussions, interviews, reporting, etc
- Long presentations using visual aids
- Listening and viewing activities with follow up activities like discussions, filling up worksheets, writing exercises (using language lab wherever necessary/possible) etc
- Projects like group reports, mock interviews etc using a combination of two or more of the language skills

EVALUATION PATTERN:

Internal assessment: 20%

3 tests of which two are pen and paper tests and the other is a combination of different modes of assessment like

- Project
- Assignment
- Report
- Creative writing, etc.

All the four skills are to be tested with equal weightage given to each.

- ✓ Speaking assessment: Individual presentations, Group discussions
- ✓ Reading assessment: Reading passages with comprehension questions graded following Bloom's taxonomy
- ✓ Writing assessment: Writing essays, CVs, reports etc. Writing should include grammar and vocabulary.
- ✓ Listening/Viewing assessment: Lectures, dialogues, film clippings with questions on verbal as well as audio/visual content graded following Bloom's taxonomy.

End Semester Examination: 80%

MA6251 **MATHEMATICS – II** **L T P C**
3 1 0 4

OBJECTIVES:

- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
- To acquaint the student with the concepts of vector calculus needed for problems in all engineering disciplines.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow the of electric current.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I VECTOR CALCULUS 9+3

Gradient, divergence and curl – Directional derivative – Irrotational and solenoidal vector fields – Vector integration – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Simple applications involving cubes and rectangular parallelopipeds.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS 9+3

Higher order linear differential equations with constant coefficients – Method of variation of parameters – Cauchy's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

UNIT III LAPLACE TRANSFORM 9+3

Laplace transform – Sufficient condition for existence – Transform of elementary functions – Basic properties – Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Transforms of unit step function and impulse functions – Transform of periodic functions. Inverse Laplace transform -Statement of Convolution theorem – Initial and final value theorems – Solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

UNIT IV ANALYTIC FUNCTIONS 9+3

Functions of a complex variable – Analytic functions: Necessary conditions – Cauchy-Riemann equations and sufficient conditions (excluding proofs) – Harmonic and orthogonal properties of analytic function – Harmonic conjugate – Construction of analytic functions – Conformal mapping: $w = z+k$, kz, $1/z$, z^2, e^z and bilinear transformation.

UNIT V COMPLEX INTEGRATION 9+3

Complex integration – Statement and applications of Cauchy's integral theorem and Cauchy's integral formula – Taylor's and Laurent's series expansions – Singular points – Residues – Cauchy's residue theorem – Evaluation of real definite integrals as contour integrals around unit circle and semi-circle (excluding poles on the real axis).

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- The subject helps the students to develop the fundamentals and basic concepts in vector calculus, ODE, Laplace transform and complex functions. Students will be able to solve problems related to engineering applications by using these techniques.

TEXT BOOKS:

1. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd.,2011.
2. Grewal. B.S, "Higher Engineering Mathematics", 41st Edition, Khanna Publications, Delhi, 2011.

REFERENCES:

1. Dass, H.K., and Er. Rajnish Verma," Higher Engineering Mathematics", S. Chand Private Ltd., 2011
2. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2012.
3. Peter V. O'Neil," Advanced Engineering Mathematics", 7th Edition, Cengage learning, 2012.
4. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2008.
5. Sivarama Krishna Das P. and Rukmangadachari E., "Engineering Mathematics" Volume II, Second Edition, PEARSON Publishing, 2011.

PH6251 ENGINEERING PHYSICS – II L T P C
3 0 0 3

OBJECTIVES:

- To enrich the understanding of various types of materials and their applications in engineering and technology.

UNIT I CONDUCTING MATERIALS 9

Conductors – classical free electron theory of metals – Electrical and thermal conductivity – Wiedemann – Franz law – Lorentz number – Draw backs of classical theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration in metals.

UNIT II SEMICONDUCTING MATERIALS 9

Intrinsic semiconductor – carrier concentration derivation – Fermi level – Variation of Fermi level with temperature – electrical conductivity – band gap determination – compound semiconductors -direct and indirect band gap- derivation of carrier concentration in n-type and p-type semiconductor – variation of Fermi level with temperature and impurity concentration — Hall effect –Determination of Hall coefficient – Applications.

UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Origin of magnetic moment – Bohr magneton – comparison of Dia, Para and Ferro magnetism – Domain theory – Hysteresis – soft and hard magnetic materials – antiferromagnetic materials – Ferrites and its applications

Superconductivity: properties – Type I and Type II superconductors – BCS theory of superconductivity(Qualitative) - High T_c superconductors – Applications of superconductors – SQUID, cryotron, magnetic levitation.

UNIT IV DIELECTRIC MATERIALS 9

Electrical susceptibility – dielectric constant – electronic, ionic, orientational and space charge polarization – frequency and temperature dependence of polarisation – internal field – Claussius – Mosotti relation (derivation) – dielectric loss – dielectric breakdown – uses of dielectric materials (capacitor and transformer) – ferroelectricity and applications.

UNIT V ADVANCED ENGINEERING MATERIALS 9

Metallic glasses: preparation, properties and applications. Shape memory alloys (SMA): Characteristics, properties of NiTi alloy, application, Nanomaterials– Preparation -pulsed laser deposition – chemical vapour deposition – Applications – NLO materials –Birefringence-optical Kerr effect – Classification of Biomaterials and its applications

TOTAL: 45 PERIODS

OUTCOMES:

- The students will have the knowledge on physics of materials and that knowledge will be used by them in different engineering and technology applications.

TEXT BOOKS:

1. Arumugam M., Materials Science. Anuradha publishers, 2010
2. Pillai S.O., Solid State Physics. New Age International(P) Ltd., publishers, 2009

REFERENCES:

1. Palanisamy P.K. Materials Science. SCITECH Publishers, 2011
2. Senthilkumar G. Engineering Physics II. VRB Publishers, 2011
3. Mani P. Engineering Physics II. Dhanam Publications, 2011
4. Marikani A. Engineering Physics. PHI Learning Pvt., India, 2009

CY6251 ENGINEERING CHEMISTRY - II L T P C
3 0 0 3

OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- Principles of electrochemical reactions, redox reactions in corrosion of materials and methods for corrosion prevention and protection of materials.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.

UNIT I WATER TECHNOLOGY 9

Introduction to boiler feed water-requirements-formation of deposits in steam boilers and heat exchangers- disadvantages (wastage of fuels, decrease in efficiency, boiler explosion) prevention of scale formation -softening of hard water -external treatment zeolite and demineralization - internal treatment- boiler compounds (phosphate, calgon, carbonate, colloidal) - caustic embrittlement -boiler corrosion-priming and foaming- desalination of brackish water –reverse osmosis.

UNIT II ELECTROCHEMISTRY AND CORROSION 9

Electrochemical cell - redox reaction, electrode potential- origin of electrode potential-oxidation potential- reduction potential, measurement and applications - electrochemical series and its significance - Nernst equation (derivation and problems). Corrosion- causes- factors-types-chemical, electrochemical corrosion (galvanic, differential aeration), corrosion control - material selection and design aspects - electrochemical protection – sacrificial anode method and impressed current cathodic method. Paints- constituents and function. Electroplating of Copper and electroless plating of nickel.

UNIT III ENERGY SOURCES 9

Introduction- nuclear energy- nuclear fission- controlled nuclear fission- nuclear fusion-differences between nuclear fission and fusion- nuclear chain reactions- nuclear reactor power

generator- classification of nuclear reactor- light water reactor- breeder reactor- solar energy conversion- solar cells- wind energy. Batteries and fuel cells:Types of batteries- alkaline battery- lead storage battery- nickel-cadmium battery- lithium battery- fuel cell H_2 -O_2 fuel cell- applications.

UNIT IV ENGINEERING MATERIALS 9

Abrasives: definition, classification or types, grinding wheel, abrasive paper and cloth. Refractories: definition, characteristics, classification, properties – refractoriness and RUL, dimensional stability, thermal spalling, thermal expansion, porosity; Manufacture of alumina, magnesite and silicon carbide, Portland cement- manufacture and properties - setting and hardening of cement, special cement- waterproof and white cement–properties and uses. Glass - manufacture, types, properties and uses.

UNIT V FUELS AND COMBUSTION 9

Fuel: Introduction- classification of fuels- calorific value- higher and lower calorific values- coal- analysis of coal (proximate and ultimate)- carbonization- manufacture of metallurgical coke (Otto Hoffmann method) - petroleum- manufacture of synthetic petrol (Bergius process)- knocking- octane number - diesel oil- cetane number - natural gas- compressed natural gas(CNG)- liquefied petroleum gases(LPG)- producer gas- water gas. Power alcohol and bio diesel. Combustion of fuels: introduction- theoretical calculation of calorific value- calculation of stoichiometry of fuel and air ratio- ignition temperature- explosive range - flue gas analysis (ORSAT Method).

TOTAL: 45 PERIODS

OUTCOMES:

- The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

TEXT BOOKS:

1. Vairam S, Kalyani P and SubaRamesh.,"Engineering Chemistry"., Wiley India PvtLtd.,New Delhi., 2011
2. DaraS.S,UmareS.S."Engineering Chemistry", S. Chand & Company Ltd., New Delhi , 2010

REFERENCES:

1 Kannan P. and Ravikrishnan A., "Engineering Chemistry", Sri Krishna Hi-tech Publishing Company Pvt. Ltd. Chennai, 2009

2. AshimaSrivastava and Janhavi N N., "Concepts of Engineering Chemistry", ACME Learning Private Limited., New Delhi., 2010.
3. RenuBapna and Renu Gupta., "Engineering Chemistry", Macmillan India Publisher Ltd., 2010.

4 Pahari A and Chauhan B., "Engineering Chemistry"., Firewall Media., New Delhi., 2010

GE6252 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C

4 0 0 4

OBJECTIVES:

- To explain the basic theorems used in Electrical circuits and the different components and function of electrical machines.
- To explain the fundamentals of semiconductor and applications.
- To explain the principles of digital electronics
- To impart knowledge of communication.

UNIT I ELECTRICAL CIRCUITS & MEASURMENTS 12

Ohm's Law – Kirchoff's Laws – Steady State Solution of DC Circuits – Introduction to AC Circuits – Waveforms and RMS Value – Power and Power factor – Single Phase and Three Phase Balanced Circuits.

Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters.

UNIT II ELECTRICAL MECHANICS 12

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single Phase Transformer, single phase induction Motor.

UNIT III SEMICONDUCTOR DEVICES AND APPLICATIONS 12

Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulation.

Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics – Elementary Treatment of Small Signal Amplifier.

UNIT IV DIGITAL ELECTRONICS 12

Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders – Flip-Flops – Registers and Counters – A/D and D/A Conversion (single concepts)

UNIT V FUNDAMENTALS OF COMMUNICATION ENGINEERING 12

Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations.

Communication Systems: Radio, TV, Fax, Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

TOTAL: 60 PERIODS

OUTCOMES:

- ability to identify the electrical components explain the characteristics of electrical machines.
- ability to identify electronics components and use of them to design circuits.

TEXT BOOKS:

1. Mittle N., "Basic Electrical Engineering", Tata McGraw Hill Edition, New Delhi, 1990.
2. Sedha R.S., "Applied Electronics", S. Chand & Co., 2006.

REFERENCES:

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, "Basic Electrical, Electronics and Computer Engineering", Tata McGraw Hill, Second Edition, 2006.
2. Nagsarkar T K and Sukhija M S, "Basics of Electrical Engineering", Oxford press 2005.
3. Mehta V K, "Principles of Electronics", S.Chand & Company Ltd, 1994.
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. Premkumar N, "Basic Electrical Engineering", Anuradha Publishers, 2003.

GE6253 ENGINEERING MECHANICS L T P C
3 1 0 4

OBJECTIVES:

- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

UNIT I BASICS AND STATICS OF PARTICLES 12

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces –– Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility .

UNIT II EQUILIBRIUM OF RIGID BODIES 12

Free body diagram – Types of supports –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

UNIT III PROPERTIES OF SURFACES AND SOLIDS 12

Centroids and centre of mass– Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem –Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 12

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 12

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

TOTAL : 60 PERIODS

OUTCOMES:

- ability to explain the differential principles applies to solve engineering problems dealing with force, displacement, velocity and acceleration.
- ability to analyse the forces in any structures.
- ability to solve rigid body subjected to dynamic forces.

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

REFERENCES:

1. Hibbeller, R.C and Ashok Gupta, "Engineering Mechanics: Statics and Dynamics", 11th Edition, Pearson Education 2010.
2. Irving H. Shames and Krishna Mohana Rao. G., "Engineering Mechanics – Statics and Dynamics", 4th Edition, Pearson Education 2006.
3. Meriam J.L. and Kraige L.G., " Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2", Third Edition, John Wiley & Sons,1993.
4. Rajasekaran S and Sankarasubramanian G., "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.
5. Bhavikatti, S.S and Rajashekarappa, K.G., "Engineering Mechanics", New Age

International (P) Limited Publishers, 1998.
6. Kumar, K.L., "Engineering Mechanics", 3rd Revised Edition, Tata McGraw-Hill Publishing company, New Delhi 2008.

GE6261 COMPUTER AIDED DRAFTING AND MODELING LABORATORY L T P C
0 1 2 2

OBJECTIVES:

- To develop skill to use software to create 2D and 3D models.

List of Exercises using software capable of Drafting and Modeling

1. Study of capabilities of software for Drafting and Modeling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.
2. Drawing of a Title Block with necessary text and projection symbol.
3. Drawing of curves like parabola, spiral, involute using Bspline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views (eg. V-block, Base of a mixie, Simple stool, Objects with hole and curves).
6. Drawing of a plan of residential building (Two bed rooms, kitchen, hall, etc.)
7. Drawing of a simple steel truss.
8. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
9. Drawing isometric projection of simple objects.
10. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.

Note: Plotting of drawings must be made for each exercise and attached to the records written by students.

TOTAL: 45 PERIODS

OUTCOMES:

- ability to use the software packers for drafting and modeling
- ability to create 2D and 3D models of Engineering Components

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

Sl.No	Description of Equipment	Quantity
1.	Pentium IV computer or better hardware, with suitable graphics facility	30 No.
2.	Licensed software for Drafting and Modeling.	30 Licenses
3.	Laser Printer or Plotter to print / plot drawings	2 No.

GE6262 PHYSICS AND CHEMISTRY LABORATORY – II L T P C
0 0 2 1

PHYSICS LABORATORY – II

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics and properties of matter.

LIST OF EXPERIMENTS

(Any FIVE Experiments)

1. Determination of Young's modulus by uniform bending method
2. Determination of band gap of a semiconductor
3. Determination of Coefficient of viscosity of a liquid –Poiseuille's method
4. Determination of Dispersive power of a prism - Spectrometer
5. Determination of thickness of a thin wire – Air wedge method
6. Determination of Rigidity modulus – Torsion pendulum

OUTCOMES:

- The students will have the ability to test materials by using their knowledge of applied physics principles in optics and properties of matter.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1. Traveling microscope, meter scale, Knife edge, weights
2. Band gap experimental set up
3. Burette, Capillary tube, rubber tube, stop clock, beaker and weighing balance
4. spectrometer, prism, sodium vapour lamp.
5. Air-wedge experimental set up.
6. Torsion pendulum set up.

   (vernier Caliper, Screw gauge, reading lens are required for most of the experiments)

CHEMISTRY LABORATORY - II

OBJECTIVES:

- To make the student acquire practical skills in the wet chemical and instrumental methods for quantitative estimation of hardness, alkalinity, metal ion content, corrosion in metals and cement analysis.

LIST OF EXPERIMENTS

(Any FIVE Experiments)

1 Determination of alkalinity in water sample
2 Determination of total, temporary & permanent hardness of water by EDTA method
3 Estimation of copper content of the given solution by EDTA method
4 Estimation of iron content of the given solution using potentiometer
5 Estimation of sodium present in water using flame photometer
6 Corrosion experiment – weight loss method
7 Conductometric precipitation titration using $BaCl_2$ and Na_2SO_4
8 Determination of CaO in Cement.

TOTAL: 30 PERIODS

OUTCOMES:

- The students will be conversant with hands-on knowledge in the quantitative chemical analysis of water quality related parameters, corrosion measurement and cement analysis.

REFERENCES:

1. Daniel R. Palleros, “Experimental organic chemistry” John Wiley & Sons, Inc., New York, 2001.
2. Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., “Vogel’s Textbook of practical organic chemistry, LBS Singapore ,1994.
3. Jeffery G.H, Bassett J., Mendham J. and Denny R.C., “Vogel’s Text book of quantitative analysis chemical analysis”, ELBS 5th Edn. Longman, Singapore publishers, Singapore, 1996.
4. Kolthoff I.M. and Sandell E.B. et al. Quantitative chemical analysis, McMillan, Madras 1980

- **Laboratory classes on alternate weeks for Physics and Chemistry.**

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

1.	Potentiometer	-	5 Nos
2.	Flame photo meter	-	5 Nos
3.	Weighing Balance	-	5 Nos
4.	Conductivity meter	-	5 Nos

Common Apparatus : Pipette, Burette, conical flask, percelain tile, dropper (30 Nos each)

GE6263 COMPUTER PROGRAMMING LABORATORY

L	T	P	C
0	1	2	2

OBJECTIVES:

The Students should be made to

- Be exposed to Unix shell commands
- Be familiar with an editor on Unix
- Learn to program in Shell script
- Learn to write C programme for Unix platform

LIST OF EXPERIMENTS

1. UNIX COMMANDS **15**

Study of Unix OS - Basic Shell Commands - Unix Editor

2. SHELL PROGRAMMING **15**

Simple Shell program - Conditional Statements - Testing and Loops

3. C PROGRAMMING ON UNIX **15**

Dynamic Storage Allocation-Pointers-Functions-File Handling

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students should be able to:

- Use Shell commands
- Design of Implement Unix shell scripts
- Write and execute C programs on Unix

HARDWARE / SOFTWARE REQUIREMENTS FOR A BATCH OF 30 STUDENTS

Hardware

- 1 UNIX Clone Server
- 3 3 Nodes (thin client or PCs)
- Printer – 3 Nos.

Software

- OS – UNIX Clone (33 user license or License free Linux)
- Compiler - C

EL6302 ORGANIC CHEMISTRY L T P C
3 0 0 3

OBJECTIVE:

To enable the students to learn the type of components in which organic reactions take place and also to know the preparation of the essential organic compounds.

UNIT I ORGANIC REACTION MECHANISM 9

Electrophilic reactions-Friedel crafts reaction, Riemer Tiemenn reaction, Beckmann rearrangements; nucleophilic reactions- aldol condensation, perkin reaction, benzoin condensation; free radical reaction-halogenation of alkane, addition of HBr on alkene in presence of peroxide; allylic halogenation - using N-Bromo Succinamide (NBS), thermal halogenation of alkene $CH_3 – CH = CH_2$

UNIT II CARBOHYDRATES 9

Introduction – mono and disaccharides – important reactions – polysaccarides – starch and cellulose – derivatives of cellulose – carboxy methyl cellulose and gun cotton – structural aspects of cellulose

UNIT III POLYNUCLEAR AROMATICS AND HETEROCYCLES 9

Classification of polynuclear aromatics. naphthalene preparation, properties and uses. Classification of heterocyclic compounds. Furan, thiophene, pyridine preparation, properties and uses

UNIT IV AMINO ACIDS AND PYRROLE 9

Classification and properties of Amino acids – composition and classification of proteins – tests for proteins – amino acids in proteins – estimation of general properties and relations of proteins – hydrolysis of proteins.

UNIT V DRUGS, PESTICIDES & DYES 9

Classification and properties of drugs. Penicilian sulpha drugs, mode of action, synthesis of sulphanilamide, chloroquine and chloroamphenicol, pesticides - classes. Synthesis of DDT and methoxychlor.

Colour and constitution, chromogen and chromophore. Classification of dyes based on structure and mode of dyeing. Synthesis of dyes. Malachite green, methyl orange, congo red, phenolphthalein.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course students will have knowledge on various reaction mechanism, preparation of organic compounds and their properties.

TEXT BOOKS:

1. B.S.Bhal and Arun Bhal, “A Text Book of Organic Chemistry”, 17th edition, S Chand & Co. New Delhi, 2005.
2. Robert T.Morrison and Robert N Byod “Organic Chemistry”, 6th edition, Prince Hall of India, New Delhi, 2001.

REFERENCES:

1. Jonathan Clayden, Nick Greeves, Staurt Warren and Peter Wothers, “Organic Chemistry”, Oxford University Press, 1st edition, New Delhi, 2001.

2. K.S. Tiwari, N.K. Vishnoi, S.N. Mehrotra, “A Text Book of Organic Chemistry”, Vikas Publishing House , 2nd Revised edition, New Delhi, 1998.

CH6404 MECHANICAL OPERATIONS L T P C
3 0 0 3

OBJECTIVE:
The students will learn characterization of solids, size reduction, techniques of solid fluid separation and mixing

UNIT I **9**
General characteristics of solids, different techniques of size analysis, shape factor, surface area determination, estimation of particle size. Screening methods and equipment, screen efficiency, ideal and actual screens.

UNIT II **9**
Laws of size reduction, energy relationships in size reduction, methods of size reduction, classification of equipments, crushers, grinders, disintegrators for coarse, intermediate and fine grinding, power requirement, work index; size enlargement - principle of granulation, briquetting, pelletisation, and flocculation.

UNIT III **9**
Gravity settling, sedimentation, thickening, elutriation, double cone classifier, rake classifier, bowl classifier. Centrifugal separation - continuous centrifuges, super centrifuges, design of basket centrifuges; industrial dust removing equipment, cyclones and hydro cyclones, electrostatic and magnetic separators, heavy media separations, floatation, jigging

UNIT IV **9**
Theory of filtration, Batch and continuous filters, Flow through filter cake and filter media, compressible and incompressible filter cakes, filtration equipments - selection, operation and design of filters and optimum cycle of operation, filter aids.

UNIT V **9**
Mixing and agitation - Mixing of liquids (with or without solids), mixing of powders, selection of suitable mixers, power requirement for mixing. Storage and Conveying of solids - Bunkers, silos, bins and hoppers, transportation of solids in bulk, conveyer selection, different types of conveyers and their performance characteristics.

TOTAL : 45 PERIODS

OUTCOME:
The students would understand about solids, their characterization, handling and various processes involving solids. The students will have knowledge on basic theory, calculations and machinery involved in various solid handling operations.

TEXT BOOKS:
1. McCabe, W.L., Smith, J.C., and Harriot, P., “Unit Operations in Chemical Engineering”, 7th Edn., McGraw-Hill, 2005.
2. Badger W.L. and Banchero J.T., “Introduction to Chemical Engineering”, Tata McGraw Hill, 1997.
3. Foust, A. S., Wenzel, L.A., Clump, C.W., Naus, L., and Anderson, L.B., “Principles of Unit Operations”, 2nd Edn., John Wiley & Sons, 1994.

REFERENCE:

1. Coulson, J.M. and Richardson, J.F., “Chemical Engineering” Vol. I, 4th Edn., Asian Books Pvt. Ltd., India, 1998.

EE6351 ELECTRICAL DRIVES AND CONTROLS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basic concepts of different types of electrical machines and their performance.
- To study the different methods of starting D.C motors and induction motors.
- To study the conventional and solid-state drives.

UNIT I INTRODUCTION 8

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives – heating and cooling curves – Loading conditions and classes of duty – Selection of power rating for drive motors with regard to thermal overloading and Load variation factors

UNIT II DRIVE MOTOR CHARACTERISTICS 9

Mechanical characteristics – Speed-Torque characteristics of various types of load and drive motors – Braking of Electrical motors – DC motors: Shunt, series and compound - single phase and three phase induction motors.

UNIT III STARTING METHODS 8

Types of D.C Motor starters – Typical control circuits for shunt and series motors – Three phase squirrel cage and slip ring induction motors.

UNIT IV CONVENTIONAL AND SOLID STATE SPEED CONTROL OF D.C. DRIVES 10

Speed control of DC series and shunt motors – Armature and field control, Ward-Leonard control system - Using controlled rectifiers and DC choppers –applications

UNIT V CONVENTIONAL AND SOLID STATE SPEED CONTROL OF A.C.DRIVES 10

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications.

TOTAL : 45 PERIODS

OUTCOME:

Students able to describe the structure of Electric Drive systems and their role in various applications such as flexible production systems, energy conservation, renewable energy, transportation etc., making Electric Drives an enabling technology.

TEXT BOOKS:

1. Vedam Subrahmaniam, “Electric Drives (concepts and applications)”, Tata McGraw-Hill, 2001
2. Nagrath.I.J. & Kothari.D.P, “Electrical Machines”, Tata McGraw-Hill, 1998

REFERENCES:

1. Pillai.S.K “A first course on Electric drives”, Wiley Eastern Limited, 1998
2. M.D.Singh, K.B.Khanchandani, “Power Electronics”, Tata McGraw-Hill, 1998
3. H.Partab, “Art and Science and Utilisation of electrical energy”, Dhanpat Rai and Sons, 1994.

MA6351 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C

3 1 0 4

OBJECTIVES:

- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 9 + 3

Formation of partial differential equations – Singular integrals -- Solutions of standard types of first order partial differential equations - Lagrange's linear equation -- Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II FOURIER SERIES 9 + 3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier series – Parseval's identity – Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9 + 3

Classification of PDE – Method of separation of variables - Solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (excluding insulated edges).

UNIT IV FOURIER TRANSFORMS 9 + 3

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 9 + 3

Z- transforms - Elementary properties – Inverse Z - transform (using partial fraction and residues) – Convolution theorem - Formation of difference equations – Solution of difference equations using
Z - transform.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- The understanding of the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.

TEXT BOOKS:

1. Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
2. Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.
3. Narayanan.S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students" Vol. II & III, S.Viswanathan Publishers Pvt Ltd. 1998.

REFERENCES:

1. Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd , 2007.
2. Ramana.B.V., "Higher Engineering Mathematics", Tata Mc-GrawHill Publishing Company Limited, NewDelhi, 2008.

3. Glyn James, "Advanced Modern Engineering Mathematics", 3rd Edition, Pearson Education, 2007.
4. Erwin Kreyszig, "Advanced Engineering Mathematics", 8th Edition, Wiley India, 2007.
5. Ray Wylie. C and Barrett.L.C, "Advanced Engineering Mathematics" Tata Mc Graw Hill Education Pvt Ltd, Sixth Edition, New Delhi, 2012.
6. Datta.K.B., "Mathematical Methods of Science and Engineering", Cengage Learning India Pvt Ltd, Delhi, 2013.

CH6403 CHEMICAL PROCESS CALCULATIONS L T P C
3 0 0 3

OBJECTIVE:
To teach concept of degree of freedom and its application to solution of mass and energy balance equations for single and network of units and introduce to process simulators.

UNIT I **6**
Units, dimensions and conversion; Process variables and properties; Stoichiometric Equations, Degrees of freedom.

UNIT II **11**
Introduction to material balances. Material balance problems for single units; Stoichiometry and Chemical reaction equations; material balance for processes involving reaction bypass, purging, recycle operations.

UNIT III **11**
Ideal gases, Real gases, Single component two phase systems, Multiple component phase systems, Phase rule, Phase equilbria, Combustion processes.

UNIT IV **11**
Energy balances, Conservation of Energy processes without reaction, Heat capacity, Energy balances with chemical reaction, Efficiency applications.

UNIT V **6**
Application of energy balances. Unsteady state material and energy balances. Solving material and energy balances using process simulators.

TOTAL: 45 PERIODS

OUTCOME:
The students would be able to understand chemical engineering calculations, establish mathematical methodologies for the computation of material balances, energy balances.

TEXT BOOKS:
1. Himmelblau, D.M., “Basic Principles and Calculations in Chemical Engineering”, EEE Sixth Edition, Prentice Hall Inc., 2003
2. Felder, R. M. and Rousseau, R. W., “Elementary Principles of Chemical Processes”,3rd Edn., John Wiley & Sons, New York, 2000.
3. Bhatt, B.L., Vora, S.M., “Stoichiometry “, 4th Edition,Tata McGraw-Hill (2004)

REFERENCES:
1. Hougen O A, Watson K M and Ragatz R A, “Chemical process principles” Part I, CBS publishers (1973).
2. Venkatramani. V, Anatharaman. N and Meera Shariffa Begam “ Process Calculations” Printice Hall of India, New Delhi,
3. K.V.Narayanan,B.Lakshmipathy,”Stochiometry and ProcessCalculation”, PHI Learning Ltd.(2013).

CH6303 PHYSICAL CHEMISTRY L T P C

3 0 0 3

OBJECTIVE:

To enable the students to acquire knowledge in the field of electrochemistry, solubility behaviour, chemical reaction kinetics, photochemical reactions and colloidal chemistry towards different applications.

UNIT I ELECTROCHEMISTRY 9

Electrical Resistance – Specific Resistance – Electrical conductance – Specific conductance – Equivalent conductance – Cell constant- Determination of cell constant – variation of conductance with dilution – Kohlrausch's law –Single electrode potential –Galvanic cell – Cu – Zn cell - EMF and its measurement – Reference electrode – Standard Hydrogen Electrode – Calornel electrode – Nernst equation - Electrochemical series – Applications of EMF Measurements: Fuel cells – Hydrogen -Oxygen fuel cell .

UNIT II CHEMICAL KINETICS 9

Rate of a reaction-Order of a reaction – Examples and rate equations for Zero order, First order, Second order and Third order reactions –Molecularity of a reaction – Unimolecular and Bimolecular reactions – Half life period– Kinetics of parallel and opposing reactions – Activation energy – Arrhenius equation –Collision theory of reaction rates – Theory of absolute reaction rates – Michalis Menton kinetics of enzyme catalyzed reactions.

UNIT III PHOTOCHEMISTRY 9

Laws of Photochemistry, Beer–Lambert's law- Grothus & Drapper's law- Stark Einstein's law- Quantum efficiency– Reason for difference in quantum efficiency –Method of determination of quantum yield. Photochemical reactions, Actinometry – Uranyl oxalate method only – Kinetics and mechanism of Hydrogen – Bromine reaction, Hydrogen – Chlorine reaction – Photosensitization- Photo inhibitor- Chemiluminescence.

UNIT IV COLLOIDS 9

Introduction to colloids – properties of colloids – coagulation of solutions – Origin of charge on colloidal particles – Determination of size of colloidal particles – Donnan Membrane equilibrium – Emulsions – Gels – Applications of colloids – Nanoparticles (Au, Ag, Pt) – Preparation – Characterization – Properties – Application in catalysis and drug delivery systems.

UNIT V THE DISTRIBUTION LAW 9

Distribution co-efficient - Distribution Law –– Conditions for the validity of the Distribution law – I2–CCl4–H2O System – Nature of interaction of the solute with one of the solvents – Dissociation- Association – Applications of Distribution law – Process of Extraction.

TOTAL : 45 PERIODS

OUTCOME:

Upon completion of this course, the students would understand the chemical equilibria, phase equilibria, electrochemical equilibria and biochemical reactions equilibria towards different applications.

TEXT BOOKS:

1. Kund and Jain, Physical Chemistry, S.Chand and Company, New Delhi (1996).
2. Puri B.H. Sharma L.R. and M.S.Prathama, "Principles of Physical Chemisry", S.Chand and Company, New Delhi (2001).
3. B.S.Bahl, Arun Bahl and G.D.Tuli, "Essentials of Physical Chemistry", S.Chand and

Company, New Delhi (2005).

REFERENCES:

1. Gordon M. Barrow, Physical Chemistry, Sixth Edition, Tata McGraw Hill (1998).
2. Peter Atkins & Julio de Paula, Atkins' Physical Chemistry, 7th Edition, Oxford university press.(2002).

CH6311 ORGANIC CHEMISTRY LABORATORY L T P C

0 0 3 2

OBJECTIVE:

To learn basic principles involved in analysis and synthesis of different organic derivatives.

LIST OF EXPERIMENTS

1. Quantitative analysis of organic compounds – Identification of aliphatic/aromatic, saturated/unsaturated compounds.
2. Identification and characterization of various functional groups by their characteristic reactions:
   a) alcohol, b) aldehyde, c) ketone, d) carboxylic acid, e) phenol, f) ester, g) primary, secondary and tertiary amines h) imide i) nitro compounds.
3. Analysis of an unknown organic compound and preparation of suitable solid derivatives.
4. Analysis of carbohydrates.
5. Analysis of proteins.
6. Methodology of filtration and recrystallization.
7. Introduction to organic synthetic procedures:
   i. Acetylation – Preparation of acetanilide from aniline.

   ii. Hydrolysis – Preparation of salycilic acid from methyl salyciliate. iii. Substitution – Conversion of acetone to iodoform.

   iv. Nitration – Preparation of m-dinitrobenzene from nitrobenzene.

   v. Oxidation – Preparation of benzoic acid from benzaldehyde/ benzyl alcohol

TOTAL : 45 PERIODS

OUTCOME:

The student is able to identify what distinguishes a strong and weak nucleophile and recall the rules of reactions. The student shows their mastery of nomenclature since ethyl bromide is not drawn out. The student analyzes a list of compounds and determines their reactivity.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Silica Crucible
2. Heating Mantle
3. Muffle Furnace
4. Hot air oven
5. Desiccator
6. Vacuum pump
7. Condenser
8. Reflux Condenser

REFERENCES:

1. Vogels's Text Book of Practical Organic Chemistry, Fifth Edition, Longman Singapore Publishers Pte. Ltd., Singapore (1989).
2. Organic Chemistry Lab Manual, Chemistry Division, Chemical Engineering Departemnt,

A.C. Tech, Anna University (2007).

EI6411 ELECTRICAL MACHINES LABORATORY L T P C
0 0 3 2

OBJECTIVE:

To impart hands on experience in verification of circuit laws and theorems, measurement of circuit parameters, study of circuit characteristics and simulation of time response. To expose the students to the basic operation of electrical machines and help them to develop experimental skills.

LIST OF EXPERIMENTS

1. Open circuit characteristics of D.C. shunt generator.
2. Load characteristics of D.C. shunt generator.
3. Load test on D.C. shunt motor.
4. Load test on D.C. series motor.
5. Swinburne's test
6. speed control of D.C. shunt motor.
7. Load test on single phase transformer
8. open circuit and short circuit tests on single phase transformer(Determination of equivalent circuit parameters).
9. Load test on single phase induction motor.
10. No load and blocked rotor tests on three phase induction motor (Determination of equivalent circuit parameters)
11. Load test on Three phase induction motor.
12. Study of Starters

TOTAL: 45 PERIODS

OUTCOME:

Ability to understand and analyze Instrumentation systems and their applications to various industries

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

1. DC Shunt Motor with Loading Arrangement – 3 nos
2. Single Phase Transformer – 4 nos
3. DC Series Motor with Loading Arrangement – 1 No.
4. Three Phase Induction Motor with Loading Arrangement – 2 nos
5. Single Phase Induction Motor with Loading Arrangement – 1 No.
6. DC Shunt Motor Coupled With DC Compound Generator – 2 nos
7. DC Shunt Motor Coupled With DC Shunt Generator – 1 No.
8. Tachometer -Digital/Analog – 8 nos
9. Single Phase Auto Transformer – 2 nos
10. Three Phase Auto Transformer – 1 No.
11. Single Phase Resistive Loading Bank – 2 nos
12. Three Phase Resistive Loading Bank. – 2 nos
13. SPST switch – 2 nos

PM6311 **MACHINE DRAWING** **L T P C**
0 0 3 2

OBJECTIVE:
The main objective is to make the engineering students well trained in drawing. So that he may be able to work in different fields such as in industry, department of sales or services or in the department of drawing and design etc.

DRAWING OF MACHINE
1. One drawing sheet of symbols and basic conventions of machine elements, materials and processes as per Indian and International Standards.
2. One drawing sheet of screw threads, screwed fastenings, cotter pin joints, pipe joints, knuckle joint, riveted and welded joints etc. (minimum two views of each component)
3. One drawing sheet on detail parts and their assembly of valves, couplings, clutches, brakes, pulleys, engine parts etc.
4. One drawing sheet based on AutoCAD with all three views for at least two machine elements / components mentioned above.

TOTAL : 45 PERIODS

OUTCOMES:
- Students will be able to understand the theory of projection.
- Students will be able to know and understand the conventions and the methods of machine drawing.
- Students will be able to improve their visualization skills so that they can apply these skills in developing new products.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS
1. Pentium IV Computer or better hardware, with suitable graphics facility – 30 No.
2. Licensed software for drafting and modeling – 30 Licenses
3. Laser Printer or plotter to print / lot drawings – 2 No.

TEXT BOOKS:
1. Gopalakrishnan,K.R.” Machine Drawing” (5th Edition) Subhas Publications (1991).
2. Bhatt,N.D. “Machine Drawing”(26th Edition),Charotkar Book Stall,Anand(1991).

REFERENCES:
1. Lakshminarayana,V.& Mathur,M.L.,”A Text Book of Machine Drawing(7th Edition),Jain Brothers,New Delhi(1988-89)
2. IS-696:1972 : Code of Practice for General Engineering Drawing,Bureau of Indian Standards,New Delhi

CE6402 **STRENGTH OF MATERIALS** **LT P C**
3 1 0 4

OBJECTIVES:
- To know the method of finding slope and deflection of beams and trusses using energy theorems and to know the concept of analysing indeterminate beam
- To estimate the load carrying capacity of columns, stresses due to unsymmetrical bending and various theories for failure of material.

UNIT I ENERGY PRINCIPLES 9

Strain energy and strain energy density – strain energy due to axial load, shear, flexure and torsion – Castigliano's theorems – Maxwell's reciprocal theorems - Principle of virtual work – application of energy theorems for computing deflections in beams and trusses - Williot Mohr's Diagram.

UNIT II INDETERMINATE BEAMS 9

Concept of Analysis - Propped cantilever and fixed beams-fixed end moments and reactions – Theorem of three moments – analysis of continuous beams – shear force and bending moment diagrams.

UNIT III COLUMNS AND CYLINDER 9

Euler's theory of long columns – critical loads for prismatic columns with different end conditions; Rankine-Gordon formula for eccentrically loaded columns – Eccentrically loaded short columns – middle third rule – core section – Thick cylinders – Compound cylinders.

UNIT IV STATE OF STRESS IN THREE DIMENSIONS 9

Determination of principal stresses and principal planes – Volumetric strain –Theories of failure – Principal stress - Principal strain – shear stress – Strain energy and distortion energy theories – application in analysis of stress, load carrying capacity.

UNIT V ADVANCED TOPICS IN BENDING OF BEAMS 9

Unsymmetrical bending of beams of symmetrical and unsymmetrical sections – Shear Centre - curved beams – Winkler Bach formula.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOMES:

- students will have through knowledge in analysis of indeterminate beams and use of energy method for estimating the slope and deflections of beams and trusses.
- they will be in a position to assess the behaviour of columns, beams and failure of materials.

TEXT BOOKS:

1. Rajput R.K. "Strength of Materials (Mechanics of Solids)", S.Chand & company Ltd., New Delhi, 2010.
2. Egor P Popov, "Engineering Mechanics of Solids", 2nd edition, PHI Learning Pvt. Ltd., New Delhi, 2012

REFERENCES:

1. Kazimi S.M.A, "Solid Mechanics", Tata McGraw-Hill Publishing Co., New Delhi, 2003
2. William A .Nash, "Theory and Problems of Strength of Materials", Schaum's Outline Series, Tata McGraw Hill Publishing company ,2007.
3. Punmia B.C."Theory of Structures" (SMTS) Vol 1&II, Laxmi Publishing Pvt Ltd, New Delhi 2004.
4. Rattan.S.S., "Strength of Materials", Tata McGraw Hill Education Pvt.Ltd., New Delhi, 2011.

PM6401 FLUID MECHANICS L T P C

3 0 0 3

OBJECTIVE:

To impart to the student knowledge on fluid properties, fluid statics, dynamic characteristics for through pipes and porous medium, flow measurement and fluid machineries

UNIT I PROPERTIES OF FLUIDS AND CONCEPT OF PRESSURE 9

Introduction – Physical properties of fluids – Types of fluids – Fluid statics and its applications - Pressure – Density – Height relationships – Pressure measurement – Units and dimensions – Dimensional analysis – Dimensionless numbers**.**

UNIT II MOMEMTUM BALANCE AND ITS APPLICATIONS 9

Kinematics of fluid flow – Stream line – Stream tube – Velocity potential – Newtonian and non-newtonian fluids – Time dependent fluids – Reynolds number experiment and significance – Continuity Equation – Momentum balance – Potential flow – Bernoulli's equation – Correction for fluid friction – Correction for pump work**.**

UNIT III FLOW OF INCOMPRESSIBLE FLUIDS THROUGH DUCTS 9

Flow of incompressible fluids in pipes – Laminar and turbulent flow through closed conduits – Velocity profile and friction factor for smooth and rough pipes – Heat loss due to friction in pipes and Fittings – Introduction to compressible flow – Isentropic flow through convergent and divergent nozzles and sonic velocity.

UNIT IV FLOW OF FLUIDS THROUGH SOLIDS 9

Form drag – Skin drag – Drag co-efficient – Flow around solids and packed beds – Friction factor for packed beds – Ergun's Equation – Motion of particles through fluids – Motion under gravitational and centrifugal fields – Terminal settling velocity – Fluidization – Mechanism – Types – General properties – Applications.

UNIT V TRANSPORTATION AND METERING 9

Measurement of fluid flow – Orifice meter – Venturi meter – Pitot tube – Rotameter– Weirs and notches – Hot wire anemometers – Transportation of fluids – Positive displacement pumps – Rotary and Reciprocating pumps – Centrifugal pumps –Performance and characteristics – Air lift and diaphragm pumps.

TOTAL : 45 PERIODS

OUTCOME:

To develop a student’s skills in analyzing fluid flows through the proper use of modeling and the application of the basic fluid-flow principles.

TEXT BOOKS:

1. McCabe, W.L., Smith, J.C. and Harriott, P., "Unit operations of Chemical Engineering", Seventh Edition, McGraw-Hill, 2004.
2. Coulson, J.M., and Richardson, J.F., "Coulson and Richardson’s Chemical Engineering", Vol. I, 3rd Edition, Butterworth Heinemann Publishers, 2004.

REFERENCES:

1. Bansal, R.K., “Fluid Mechanics and Hydraulic machines”, Laxmi Publications (P) Ltd., 1995.
2. Nevers, N.D., "Fluid Mechanics for Chemical Engineers", McGraw-Hill, 1991.
3. De Nevers, L., “Fluid Mechanics for Chemical Engineers”, McGraw-Hill, 1994.

PC6501 HEAT TRANSFER L T P C

3 1 0 4

OBJECTIVE:

To learn heat transfer by conduction, convection and radiation and heat transfer equipments like evaporator and heat exchanger

UNIT I CONDUCTION 9

Modes of heat transfer – Steady and unsteady state heat transfer – Concept of heat conduction – Fourier's law of heat conduction – General heat conduction equation in spherical coordinates – One-dimensional steady state heat conduction equation for flat plate, hollow cylinder, hollow sphere –Analogy between flow of heat and flow of electricity – Effect of temperature on thermal conductivity – Critical insulation thickness– Transient heat conduction – Lumped heat parameter model.

UNIT II CONVECTION 9

Concept of heat transfer by convection – Natural and forced convection – Concept ofLMTD – Local and overall heat transfer coefficient – Application of dimension alanalysis for convection – Empirical Equations for forced convection under laminar, transient and turbulent conditions – Empirical equations for natural convection –Influence of boundary layer on heat transfer – Heat transfer through packed and fluidized beds – Heat transfer with phase change: boiling, vaporization and condensation.

UNIT III RADIATION 9

Concept of thermal radiations – Black body concept – Stefan Boltzman's law –Emissive power – Black body radiation – Emissivity – Planck's law – Radiation between black surfaces – Gray surfaces – Radiation shields – Radiation applications– Pipe still heaters.

UNIT IV HEAT EXCHANGERS 9

Heat exchanger types – Parallel and counter flow heat exchangers – Overall heat transfer coefficient – Log mean temperature difference for single pass – Correction factor for multi pass heat exchangers – Heat exchanger effectiveness – Number of transfer units – Chart for different configurations – Dirt factor.

UNIT V EVAPORATORS 9

Evaporation – Single effect and multiple effect evaporation – Boiling point elevation –Effect of liquid head – Capacity and economy of multiple effect evaporators –Evaporation equipments.

TOTAL (L : 45 + T : 15) : 60 PERIODS

OUTCOME:

Students gain knowledge in various heat transfer methodology in process engineering and to design heat transfer equipments such as furnace, boilers, heat exchangers evaporation

TEXT BOOKS:

1. Kumar, D.S., "Heat and Mass Transfer", 5th Edition, S.K. Kataria and Sons, 2000.
2. McCabe,W.L. and Smith, J.C., "Unit Operations in Chemical Engineering", 5th Edition. McGraw Hill Publishing Co., 2001.

REFERENCES:

1. Kern, D.Q., "Process Heat Transfer", Tata McGraw Hill Publishing Co., 1990.
2. Hollman, "Heat Transfer", 8th Edition, McGraw Hill, 1997.
3. Kreith, F., "Principles of Heat Transfer", 4th Edition, Harper and Row, 1976.

MA6459 NUMERICAL METHODS L T P C
3 1 0 4

OBJECTIVE:

This course aims at providing the necessary basic concepts of a few numerical methods and give procedures for solving numerically different kinds of problems occurring in Engineering and Technology.

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 10+3

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton-Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss-Jordan methods – Iterative methods of Gauss-Jacobi and Gauss-Seidel - Matrix Inversion by Gauss-Jordan method - Eigenvalues of a matrix by Power method.

UNIT II INTERPOLATION AND APPROXIMATION 8+3

Interpolation with unequal intervals - Lagrange interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 9+3

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 9+3

Single step-methods - Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge-Kutta method for solving first order equations - Multi-step methods - Milne's and Adams-Bashforth predictor-corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 9+3

Finite difference methods for solving two-point linear boundary value problems - Finite difference techniques for the solution of two dimensional Laplace's and Poisson's equations on rectangular domain – One-dimensional heat-flow equation by explicit and implicit (Crank Nicholson) methods – One-dimensional wave equation by explicit method.

TOTAL (L:45+T:15): 60 PERIODS

OUTCOME:

It helps the students to have a clear perception of the power of numerical techniques, ideas and would be able to demonstrate the applications of these techniques to problems drawn from industry, management and other engineering fields.

TEXT BOOKS:

1. Grewal, B.S. and Grewal,J.S., "Numerical methods in Engineering and Science", Khanna Publishers, New Delhi, 9th Edition, 2007.
2. Sankara Rao, K., "Numerical methods for Scientists and Engineers', Prentice Hall of India Private Ltd., New Delhi, 3rd Edition, 2007.

REFERENCES:

1. Chapra, S. C., and Canale, R. P., "Numerical Methods for Engineers", Tata McGraw-Hill, New Delhi, 5th Edition, 2007.
2. Gerald, C. F., and Wheatley, P. O., "Applied Numerical Analysis", Pearson Education, Asia, New Delhi, 6th Edition, 2006.
3. Brian Bradie, "A friendly introduction to Numerical analysis", Pearson Education, Asia, New Delhi, 2007.

PC6301 INDUSTRIAL CHEMICAL TECHNOLOGY

L	T	P	C
3	0	0	3

OBJECTIVE:

To gain Knowledge on various aspects of production engineering and understand the practical methods of production in a chemical factory.

UNIT I SULFUR, SULFURIC ACID AND CEMENT 9

Sulfur, Raw materials Sources, Mining and production of Sulfur – Sulfuric acid, Methods of production of Sulfuric acid – Contact process – Chamber process. Cement – properties of Cement – Methods of production – Overall factors for Cement industry.

UNIT II FERTILIZER INDUSTRY, FUEL AND INDUSTRIAL GASES 9

Major Components of Fertilizer industries – Nitrogen industries, ammonia, nitric acid, urea – Phosphorus industries - Phosphorus, Phosphoric acid, Super Phosphate – Potassium chloride, Potassium Sulphate – Fuel Gases – Producer gas, Water gas, Coke oven gas, Natural gas, Liquefied natural gas – Industrial gases – Carbon dioxide, hydrogen, nitrogen and oxygen.

UNIT III PULP, PAPER, SUGAR AND STARCH INDUSTRIES 9

Pulp – Methods of production – Comparison of pulping processes. Paper – types of paper products, Raw materials, Methods of production. Sugar – Methods of production – by products of the Sugar industry – Starch – Methods of production, Starch derivations.

UNIT IV PETROLEUM AND PETRO CHEMICAL INDUSTRIES 9

Petroleum – Chemical Composition, Classification of crude petroleum, Petroleum Refinery products – Petroleum Conversion processes – Pyrolysis and Cracking, Reforming Polymerization, isomerization and Alkylation – petrochemicals – methanol, chloro methanol, Acetylene and ethylene, Isopropanol, Acrylonitrile, Buta diane – Chemicals from Aromatics - Benzene, Toluene and Xylene.

UNIT V RUBBERS, POLYMERS AND SYNTHETIC FIBRE 9

Natural and Synthetic rubber, SBR – Silicone rubber – polymer – physical – chemical structure of polymers, Thermosetting and Thermoplastic materials - Polymer manufacturing processes – polyethylene, polystyrene – Resins phenolic and epoxy resins – Synthetic Fibers – Viscose rayon, Polyamides and polyesters.

TOTAL : 45 PERIODS

OUTCOME:

Student can classify the chemical process industry into industrial categories of base, intermediate end-products and specialty chemicals manufacturers.

TEXT BOOKS:

1. Dryden, C.E, Outlines of Chemical technology, II Ed., Affiliate East West press, 2003.
2. Moulin, J.A., M. Makkee, and Diepen, A.V., Chemical Process Technology, Wiley, 2001.

REFERENCES:

1. Austin, G.T., Shreve's "Chemical Process Industries", 5th ed., McGraw-Hill, 1998
2. Srikumar Koyikkal,"Chemical Process Technology and Simulation",PHI Learning Ltd (2013).

PC6402 ENGINEERING THERMODYNAMICS L T P C
3 1 0 4

OBJECTIVE:
Students will learn PVT behaviour of fluids, laws of thermodynamics, thermodynamic property relations and their application to fluid flow, power generation and refrigeration processes.

UNIT I ZEROTH AND FIRST LAWS, PROPERTIES OF PURE SUBSTANCES 9
Definitions and Concepts. Property, Thermodynamic State. Equilibrium, Energy, Work. Zeroth Law of Thermodynamics, Temperature Scale. Pure substance, Phase, Simple compressible substance, Ideal gas Equation of State, Law of corresponding states, Compressibility chart, Pressure –Volume and Temperature-volume Phase diagrams. Mollier diagram. First Law of Thermodynamics and its consequences.

UNIT II APPLICATION OF I LAW TO STEADY - STATE PROCESSES, II LAW 9
Application of I Law of Thermodynamics for Flow Process. Steady-state processes. II Law of Thermodynamics and its Applications: Limitations of the I Law of Thermodynamics, Heat Engine, Heat Pump/Refrigerator II Law of Thermodynamics – Kelvin Planck and Clausius statements. Reversible and irreversible processes,Criterion of reversibility, Carnot cycle and Carnot principles, Thermodynamic Temperature scale, Clausius inequality, Entropy.

UNIT III POWER CYCLES, THERMODYNAMIC POTENTIALS, EQUILIBRIA AND STABILITY 9
Power and Refrigeration Cycles. Thermodynamic Potentials. Maxwell relations. Thermodynamic relations. Equilibria and stability. Maxwell construction, Gibbs Phase Rule. Clapeyron equation and vapor pressure correlations.

UNIT IV PROPERTIES OF PURE COMPONENTS AND MIXTURES 9
Pure component properties: Equation of state. Ideal gas heat capacities, fundamental equations from experimental data, fugacity and corresponding states. Mixture Properties: Mixing function. Gibbs-Duhem relation for mixtures, partial molar quantities. Ideal gas mixtures and fugacities, ideal mixtures and activities, excess functions. Gibbs free energy models, infinite dilution properties. Henry's Law

UNIT V PHASE EQUILIBRIA AND CHEMICAL REACTION EQUILIBRIA 9
Phase Equilibira of Mixtures. Osmotic pressure and Osmotic coefficients. Boiling point elevation and freezing point depression. Chemical Reaction Equilibria. Reaction extent and Independent reactions. Equilibrium criteria and equilibrium constant. Standard enthalpies and Gibbs free energy, temperature and pressure effects on reactions, heterogeneous reaction, multiple chemical reactions

TOTAL (L : 45 + T : 15) : 60 PERIODS

OUTCOME:
Understand the terminology associated with engineering thermodynamics. Understand the concepts of heat, work and energy conversion, and can calculate heat and work quantities for industrial processes.

TEXT BOOKS:

1. Sonntag, Borgnakke, Van Wylen, Fundamentals of Thermodynamics, 7th Edition, Wiley India, New Delhi, 2009.
2. Smith, van Ness and Abbott, "Chemical Engineering Thermodynamics", 7th Edition, McGraw Hill, New York, 2005

REFERENCES:

1. S. I. Sandler, Chemical, Biochemical and Engineering Thermodynamics, Wiley New York, 2006
2. Y V C Rao, "Chemical Engineering Thermodynamics", Universities Press, Hyderabad 2005.
3. Pradeep ahuja," Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).
4. Gopinath Halder," Introduction to Chemical Engineering Thermodynamics", PHI Learning Ltd (2009).

CH6413 PHYSICAL CHEMISTRY LABORATORY L T P C
(Any Ten experiments) 0 0 4 2

OBJECTIVE:

To improve the practical knowledge on the properties and characteristics of solvents and mixtures.

LIST OF EXPERIMENTS

1. Partition coefficient of iodine between two immiscible solvents,
2. Equilibrium constant of $KI + I_2 \rightleftharpoons KI_3$
3. Phase diagram of binary system
4. Solubility curve for a ternary system
5. Verification of Ostwald dilution law
6. Galvanostatic / Potentiostatic polarisation measurements
8. Impedence measurements
9. Adsorption isotherm
10. Heat of solution
11. Determination of acid value in the given oils
12. Molecular weight determination

TOTAL: 60 PERIODS

OUTCOME:

The student is able to determine the properties and characteristics of solvents and mixtures.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Micro Calorimeter
2. Beckman Thermometers. Glasswares,
3. Thermometers 0 to 110 – 0°. Bottle Shakers .pH meters
4. Pressure Glass bottles. Standard Cells. Multimeters
5. Viscometers-Ostwald Cannan Ubbelholde. Voltage Stabiliser
6. Stalalmometer
7. Surface Tension Meter .Tape Heaters
8. Mantle Heaters
9. DC Power Supply. Thermostat. Cyrostats

REFERENCE:

1. Physical Chemistry experiments by Alexander Findley, McGraw-Hill IV Edition, (1976).

PM6412 MECHANICAL OPERATIONS LABORATORY L T P C
0 0 3 2

AIM

To impart knowledge on mechanical operations by practice

OBJECTIVE:
Students develop a sound working knowledge on different types of crushing equipments and separation characteristics of different mechanical operation separators.

LIST OF EXPERIMENTS

1. Sieve analysis
2. Batch filtration studies using a Leaf filter
3. Batch filtration studies using a Plate and Frame Filter press
4. Characteristics of batch Sedimentation
5. Reduction ratio in Jaw Crusher
6. Reduction ratio in Ball mill
7. Separation characteristics of Cyclone separator
8. Reduction ratio of Roll Crusher
9. Separation characteristics of Elutriator
10. Reduction ratio of Drop weight crusher
11. Size separation using Sub-Sieving

TOTAL : 45 PERIODS

OUTCOME:
Student's gain the practical knowledge and hands on various separation techniques like filtration, sedimentation, screening, elutriation, centrifugation principles which is having wide applications in various industries

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1. Sieve shaker
2. Leaf filter
3. Plate and Frame Filter Press
4. Sedimentation Jar
5. Jaw Crusher
6. Ball Mill
7. Cyclone Separator
8. Roll Crusher
9. Elutriator
10. Drop Weight Crusher

PM6411	**FLUID MECHANICS LABORATORY**	**L T P C**
		0 0 3 2

OBJECTIVE:
To learn experimentally to calibrate flow meters, find pressure loss for fluid flows and determine pump characteristics.

LIST OF EXPERIMENTS
1. Viscosity measurement of non Newtonian fluids
2. Calibration of constant and variable head meters
3. Calibration of weirs and notches
4. Open drum orifice and draining time
5. Flow through straight pipe
6. Flow through annular pipe
7. Flow through helical coil and spiral coil
8. Losses in pipe fittings and valves

9. Characteristic curves of pumps
10. Pressure drop studies in packed column
11. Hydrodynamics of fluidized bed
12. Drag coefficient of solid particle

TOTAL : 45 PERIODS

OUTCOME:
Practical knowledge on the measurement of fluid Flow and their characteristics at different operating conditions.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1. Viscometer
2. Venturi meter
3. Orifice meter
4. Rotameter
5. Weir
6. Open drum with orifice
7. Pipes and fittings
8. Helical and spiral coils
9. Centrifugal pump
10. Packed column
11. Fluidized bed

GE6351 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES
To the study of nature and the facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth's interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 12
Definition, scope and importance of Risk and hazards; Chemical hazards, Physical hazards, Biological hazards in the environment – concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers-Oxygen cycle and Nitrogen cycle – energy flow in the ecosystem – ecological succession processes – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic

species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds
Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 10

Definition – causes, effects and control measures of: (a) Air pollution (Atmospheric chemistry- Chemical composition of the atmosphere; Chemical and photochemical reactions in the atmosphere - formation of smog, PAN, acid rain, oxygen and ozone chemistry;- Mitigation procedures- Control of particulate and gaseous emission, Control of SO_2, NO_X, CO and HC) (b) Water pollution : Physical and chemical properties of terrestrial and marine water and their environmental significance; Water quality parameters – physical, chemical and biological; absorption of heavy metals - Water treatment processes. (c) Soil pollution - soil waste management: causes, effects and control measures of municipal solid wastes – (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards–role of an individual in prevention of pollution – pollution case studies –
Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and overutilization of surface and ground water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Energy Conversion processes – Biogas – production and uses, anaerobic digestion; case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Introduction to Environmental Biochemistry: Proteins –Biochemical degradation of pollutants, Bioconversion of pollutants.
Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – 12 Principles of green chemistry- nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air act – Water act – Wildlife protection act – Forest conservation act –The Biomedical Waste (Management and Handling) Rules; 1998 and amendments- scheme of labeling of environmentally friendly products (Ecomark). enforcement machinery involved in environmental legislation- central and state pollution control boards- disaster management: floods, earthquake, cyclone and landslides.
Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare –Environmental impact analysis (EIA)- -GIS-remote sensing-role of information technology in environment and human health – Case studies.

TOTAL : 45 PERIODS

OUTCOMES:

Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.

- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions
- Development and improvement in std. of living has lead to serious environmental disasters

TEXT BOOKS:

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2006).

REFERENCES:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia',Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press (2005)

PM6501 MASS TRANSFER I L T P C
3 1 0 4

OBJECTIVE:

Students will learn to determine mass transfer rates under laminar and turbulent conditions.

UNIT I DIFFUSION 9

Diffusion in fluids – Molecular and eddy diffusion – Measurement and calculation of diffusivities – Ordinary diffusion in multi component gaseous mixtures – Diffusion in solids – Molecular and Knudsen diffusion in solids – Theories of mass Transfer –Film theory, penetration theory and surface renewal theories of mass transfer.

UNIT II INTERPHASE MASS TRANSFER 9

Interphase Mass Transfer – Local and overall mass transfer coefficients – Steady state co current and counter current mass transfer process – Stage and stage efficiencies – Concept of NTU and HTU – Equilibrium and operating lines – JD Factor– Equipments for gas-liquid contact operations – Bubble columns – Tray towers and packed towers.

UNIT III ABSORPTION 9

Gas Absorption: Principles of absorption and desorption – Selection of solvents for absorption – Tray tower absorber – Absorption factor – Calculation of number of theoretical stages – Murphree efficiency – Point efficiency – Tray efficiency and overall tray efficiency – Calculation of actual number of trays.Packed tower absorber – Tower packing and characteristics – Calculation of NTU, HTU,HETP and height of absorption towers – Absorption with chemical reactions.

UNIT IV DRYING 9

Drying – Principle and definitions – Estimation of drying rates, drying rate curve – Critical and equilibrium moisture content – Calculation of drying time under constant drying conditions – Different types of dryers.

UNIT V HUMIDIFICATION AND CRYSTALLIZATION 9

Humidification – Definitions, psychometric charts – Wet bulb temperature – Methods of humidification – Types of cooling towers, spray chambers and spray ponds.Crystallization –

Factors governing nucleation and crystal growth – Theory of Crystallization – Classification of crystallizer and their applications – Product size distribution.

TOTAL : 45 PERIODS

OUTCOME:

Students apply the mass transfer concepts in the design of humidification columns, dryers and crystallisers.

TEXTBOOKS:

1. McCabe,W.L., Smith, J.C. and Harriot,P., "Unit Operations of Chemical Engineering", 6th Edition, McGraw – Hill Book Co., 2001.
2. Treybal, R.E., "Mass Transfer Operations", 3rd Edition, McGraw – Hill Book Co.,1980.

REFERENCES:

1. Coulson, J.M. and Richardson, J.F., "Chemical Engineering", Vol.I, II and III,Pergamon Press, 1977.
2. Bennett, C.O. and Myers, J.E., "Momentum, Heat and Mass Transfer", McGraw Hill Book Company, 3rd Edition, 1983.
3. Christie J. Geankoplis, "Transport Processes and Unit Operations", 3rd Edition,Prentice Hall of India Pvt. Ltd, 2000.
4. Binay K.Dutta,"Principles of Mass Transfer and Seperation Processes",PHI Learning Ltd,2013.

PC6503 PETROLEUM EXPLORATION AND EXPLOITATION TECHNIQUES L T P C
3 1 0 4

OBJECTIVE:

To understand the stages of oil and gas exploration and production

UNIT I ORIGIN AND OCCURRENCE OF PETROLEUM AND SEDIMENTRARY ENVIRONMENT 9

Origin of oil – Important factors that control petroleum occurrence – Migration and accumulation – Source and reservoir rocks – Oil bearing rocks – Continental environment – Transitional environment – Marine environment.

UNIT II EXPLORATION METHODS, WELL PROGNOSIS AND ECONOMIC ANALYSIS 9

Geological exploration methods – Geophysical exploration methods – Geochemicalmethods prognostication – Classification of drilling locations – Economic analysis – Well programme – Geotechnical order.

UNIT III GEOLOGICAL STRUCTURE AND GEOLOGGING 9

Various traps – Anticline – Fracturing – Well logging – Geological control – Gas logging– Drilling control important formation evaluation using wireline logging data.

UNIT IV DRILLING FLUIDS AND WORK COMPLETION 9

Drilling Fluids: Function, composition, and classification – Packer fluid – Casing packs –Solids removal – Completion methods – Various stimulation methods.

UNIT V OFF – SHORE TECHNOLOGY 9

Seismic technology – Sniffer survey – Drilling technology – Off-share rigs – Primary and secondary enhanced oil recovery techniques and methods – Major well complication and Remedies.

TOTAL : 60 PERIODS

OUTCOME:
The student will get exposed to different geological and geophysical methods for exploration and exploitation of oil and gas

TEXT BOOKS:

1. Bhagwan Sahay "Petroleum Exploration and Exploitation Practices" Allied Publishers Ltd., Chennai, 1994.
2. Richard Dawe, "Modern Petroleum Technology", Vol.I, Upstream, 6th Edition, John and Wiley Sons Ltd, 2000.

REFERENCES:

1. Howard B. Bradley, "Petroleum Engineering Handbook", Society of Petroleum Engineers,1987.
2. Norman J. Hyne., "Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production", 2nd Edition, Pennwell Books, 2001.
3. Shay B., "Wellsite Geological Techniques for Petroleum Exploration" Allied Publishers Ltd., 1991.

PM6502 CHEMICAL REACTION ENGINEERING L T P C
3 1 0 4

OBJECTIVE:
To gain knowledge on different types of chemical reactors, the design of chemical reactors under isothermal and non-isothermal conditions

UNIT I NON – IDEAL REACTORS 9
Residence time distribution function and its measurement – Characteristics of tracer – Mean residence time – Conversion in non-ideal flow reactors.

UNIT II HETROGENEOUS PROCESS AND SOLID CATALYSIS 9
Rate equation for heterogeneous reactions – Nature of catalysis –Adsorption isothermal and rates of adsorption – Desorption and surface reaction analysis of rate equation – Rate controlling steps.

UNIT III GAS – SOLID CATALYTIC REACTORS 9
Characteristics of catalyzed reactions – Mechanism of solid catalyzed reactions – Pore diffusion resistance combined with surface kinetics – Performance equations for reactors containing porous catalysts.

UNIT IV GAS – SOLID NON – CATALYTIC REACTORS 9
Selection of the kinetic model – Progressive – conversion model, shrinking – core model – Shrinking-core model for spherical particles of unchanging size – Shrinking-core model for cylindrical particles of unchanging size.

UNIT V GAS – LIQUID REACTIONS 9
Various ways of carrying out gas – liquid reactions catalyzed by solids – General rate equation – Resistances in series in the gas – liquid reaction on catalyst surface.

TOTAL (L : 45 + T : 15) : 60 PERIODS

OUTCOME:

Students gain knowledge on the selection of the reactor for the reaction and its design.

TEXT BOOKS:

1. Levenspiel, O., "Chemical Reaction Engineering", 3rd Edition, Wiley Asian Edition, 1990.
2. Smith, J.M., "Chemical Engineering Kinetics", 2nd Edition, McGraw Hill, 1984.

REFERENCES:

1. Scott Fogler, H., "Elements of Chemical Reaction Engineering", 4th Edition, Prentice Hall of India.2009
2. Gavanhe, K.A., "Chemical Reaction Engineering I", Nirali Prakashan Publishers, 2007.
3. Dawande, D., "Principles of Reaction Engineering", 1st Edition, Central Techno Publications, 2001.

PE6606 NATURAL GAS ENGINEERING L T P C
3 1 0 4

OBJECTIVE:

The objective of studying this subject is that student will be understanding the basic concept and applications of Natural Gas Engineering.

UNIT I PROPERTIES AND COMPOSITION OF NATURAL GAS 9

Natural gas origin – Composition of natural gas – Sources of Natural gas –Thermodynamics properties – Compressibility factor and chart for natural gas – Heating value and flammability limit of natural gas.

UNIT II ESTIMATION AND PRODUCTION OF NATURAL GAS 9

Estimation of gas reserves by volumetric method – Production of natural gas –Pressure decline method – Problems in the production of natural gas – Field separation.

UNIT III GAS FROM CONDENSATE OIL FIELDS 9

Processing of condensate well fluids – Cycling of gas condensate reservoirs – Sweep patterns – Katy cycling plant.

UNIT IV ACID GAS TREATING OF NATURAL GAS 9

Acid gas removal: Metal oxide process – Slurry process – Amine process –Carbonate washing process – Methanol based process and other process – Sulphur recovery process.

UNIT V DEHYDRATION OF NATURAL GAS AND NGL RECOVERY 9

Dehydration: Glycol dehydration – Solid desiccant dehydration.

NGL Recovery: Refrigeration process – Lean oil absorption process – Solid bed adsorption and membrane separation process – NGL fractionation.

TOTAL (L : 45 + T : 15) : 60 PERIODS

OUTCOME:

Students learn the Natural gas processing, Gas Compression, Gas Gathering and Transport Installation, Operation and trouble shooting of natural gas pipelines.

TEXT BOOKS:

1. Katz and Lee “Hand Book of Natural Gas Engineering” McGraw Hill, 1968.
2. Lyons, W.C., “Standard Handbook of Petroleum and Natural Gas Engineering”, Vol.2, Gulf Professional Publishing, Elsevier Inc., 2006.

REFERENCES:

1. Katz, D. L. and Lee, R.L., “Natural Gas Engineering”, McGraw Hill, 1990.
2. Dring, M.M., “The Natural Gas Industry – A Review of World Resources and Industrial Applications”, Butterworth, 1974.
3. Saied Mokhatab, William A. Poe, and James G. Speight, “Handbook of Natural Gas Transmission and Processing”, Gulf Professional Publishing, Elsevier Inc., 2006..

PC6401 MATERIALS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

To provide students with a strong foundation in materials science with emphasis on the fundamental scientific and engineering principles which underlie the knowledge and implementation of material structure, processing, properties, and performance of all classes of materials used in engineering systems.

UNIT I STRUCTURE OF MATERIALS 9

Introduction-classification of materials, selection of materials, properties of materials, x-ray crystallography, Bragg's law, x-ray diffraction, electron diffraction, neutron diffraction, structure of NaCl and diamond, Crystal defects - point, line, surface and volume defects, alloy formation, solid solution types, solidification of castings, structural examination using microscopy.

UNIT II METALLURGICAL PROPERTIES OF MATERIALS 9

Phase diagrams - isomorphous, eutectic, eutectoid and peritectic system. Diffusion - Fick 's laws. Mechanical properties - tension test, hardness test - brinnel, vickers, rockwell, micro hardness test - shore scleroscope. Impact test, fracture - grifiths' theory, fracture toughness, embrittlement phenomena. Fatigue and creep. Strengthening mechanisms

UNIT III TYPES OF MATERIALS 9

Classification of steel, Fe-C phase diagram, heat treatment, TTT curves, ausforming, marforming, annealing types, normalizing, tempering, hardening, effect of alloying elements, tool steels, stainless steel, cast iron - malleable and ductile types and properties. Copper and its alloys - brass, bronze, copper – nickel. Aluminium and its alloys, hardening treatment. Al cladding nickel and its alloys, titanium and its alloys, cermets, welding electric and magnetic materials, nano particles and nano structures.

UNIT IV PHYSICAL CHARACTERISTICS OF MATERIALS 9

Metals, semiconductors, insulators, electron theory, band theory, types of magnetism, domain structures, anisotrophy of materials, and application. Soft and hard magnets. Conductivity of materials, zone refining, crystal growth techniques.

UNIT V NON-METALLIC MATERIALS 9

Ceramic materials - oxides, silicates. Refractories. Glasses, enamels, abrasives, cement and concrete materials. Polymers – classification, reaction, types, mechanisms, deformation of polymers, mechanical, thermal, electrical and chemical behavior. Rubber, silicones, fluoro carbons, composites -FRP, particulates, and laminates.

TOTAL : 45 PERIODS

OUTCOME:

Students will be able to understand various material and its properties and manufacturing methods.

TEXT BOOKS:

1. V.Raghavan, "Materials Science and Engineering : A first course", V Edition, Prentice Hall of India , 2004.
2. Van Vlack L.H , "Elements of Materials Science and Engineering" (Addision Wesley series in metallurgy and materials engineering), VI Edition, Prentice Hall, 6th Edition, 1989.

REFERENCES:

1. WF.Hosford, "Material Science", Cambridge Univ. Press, New York, 2006.
2. C.Srinivasan, " Science of Engineering Materials", John Wiley, New York, 1987.

CH6611	HEAT TRANSFER LABORATORY	L T P C
		0 0 3 2

OBJECTIVE:

Students develop a sound working knowledge on different types of heat transfer equipments.

LIST OF EXPERIMENTS

1. Performance studies on Cooling Tower
2. Batch drying kinetics using Tray Dryer
3. Heat transfer in Open Pan Evaporator
4. Boiling Heat Transfer
5. Heat Transfer through Packed Bed
6. Heat Transfer in a Double Pipe Heat Exchanger
7. Heat Transfer in a Bare and Finned Tube Heat Exchanger
8. Heat Transfer in a Condenser
9. Heat Transfer in Helical Coils
10. Heat Transfer in Agitated Vessels

TOTAL : 45 PERIODS

OUTCOME:

Student should be able to calculate heat transfer by conduction, different types of convection using classical models for these phenomena

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Cooling Tower
2. Tray Dryer
3. Open Pan Evaporator
4. Boiler
5. Packed Bed
6. Double Pipe Heat Exchanger
7. Bare and Finned Tube Heat Exchanger
8. Condenser
9. Helical Coil
10. Agitated Vessel

CH6411	TECHNICAL ANALYSIS LABORATORY	L T P C
		0 0 3 2

OBJECTIVE:

To learn basic principles involved in estimation and characterization of industrially important materials.

LIST OF EXPERIMENTS

I Soap Analysis

a. Estimation of total fatty acid
b. Estimation of percentage alkali content

II. Oil Analysis

a. Estimation of free acid
b. Determination of Saponification value
c. Determination of iodine value

III. Cement Analysis

a. Estimation of Silica content
b. Estimation of mixed oxide content
c. Estimation of calcium oxide content
d. Estimation of calcium oxide by rapid method

IV. Coal Analysis

a. Estimation of Sulphur present in coal
b. Ultimate analysis of coal
c. Proximate analysis of coal

V. Analysis of Bleaching Powder

a. Estimation of available chlorine

VI. Analysis of Glycerol

a. Estimation of purity of glycerol

VII. Analysis of fuels

a. Flash point b. Fire point c. Cloud point d. Pour point e. Aniline point.

VIII. Determination of the molecular weight of the polymer by viscometry.
IX. Calorimetric measurements
X. Conductivity measurement of an electrolyte solution
XI. pH measurements

TOTAL : 45 PERIODS

OUTCOME:
At the end of this practical course, the student would have a thorough understanding on the estimation and analysis of chemical compounds.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Silica Crucible
2. Heating Mantle
3. Muffle Furnace
4. Hot air oven
5. Desiccator
6. Vacuum pump
7. Condenser
8. Reflux Condenser
9. Pensky martens closed cup apparatus

10. Cleveland open cup apparatus
11. Cloud point apparatus
12. Aniline point apparatus
13. Saybolt Viscometer
14. Redwood viscometer
15. Bomb Calorimeter
16. Junkers gas Calorimeter
17. Conductivity meter
18. pH meter

GE6674 COMMUNICATION AND SOFT SKILLS - LABORATORY BASED L T P C
0 0 4 2

OBJECTIVES:

- To enable learners to develop their communicative competence.
- To facilitate them to hone their soft skills.
- To equip them with employability skills to enhance their prospect of placements.

UNIT I LISTENING AND SPEAKING SKILLS 12

Conversational skills (formal and informal) – group discussion and interview skills – making presentations.

Listening to lectures, discussions, talk shows, news programmes, dialogues from TV/radio/Ted talk/Podcast – watching videos on interesting events on Youtube.

UNIT II READING AND WRITING SKILLS 12

Reading different genres of tests ranging from newspapers to philosophical treatises – reading strategies such as graphic organizers, summarizing and interpretation.

Writing job applications – cover letter – resume – emails – letters – memos – reports – blogs – writing for publications.

UNIT III ENGLISH FOR NATIONAL AND INTERNATIONAL EXAMINATIONS AND PLACEMENTS 12

International English Language Testing System (IELTS) – Test of English as a Foreign Language (TOEFL) – Graduate Record Examination (GRE) – Civil Service (Language related) – Verbal ability.

UNIT IV SOFT SKILLS (1) 12

Motivation – self image – goal setting – managing changes – time management – stress management – leadership traits – team work – career and life planning.

UNITV SOFT SKILLS (2) 12

Multiple intelligences – emotional intelligence – spiritual quotient (ethics) – intercultural communication – creative and critical thinking – learning styles and strategies.

TOTAL : 60 PERIODS

Teaching Methods:

1. To be totally learner-centric with minimum teacher intervention as the course revolves around practice.
2. Suitable audio/video samples from Podcast/YouTube to be used for illustrative purposes.
3. Portfolio approach for writing to be followed. Learners are to be encouraged to blog, tweet, text and email employing appropriate language.
4. GD/Interview/Role Play/Debate could be conducted off the laboratory (in a regular classroom) but learners are to be exposed to telephonic interview and video conferencing.
5. Learners are to be assigned to read/write/listen/view materials outside the classroom as well for graining proficiency and better participation in the class.

Lab Infrastructure:

S. No.	Description of Equipment (minimum configuration)	Qty Required

1	**Server**	1 No.
	• PIV System	
	• 1 GB RAM / 40 GB HDD	
	• OS: Win 2000 server	
	• Audio card with headphones	
	• JRE 1.3	
2	**Client Systems**	60 Nos.
	• PIII or above	
	• 256 or 512 MB RAM / 40 GB HDD	
	• OS: Win 2000	
	• Audio card with headphones	
	• JRE 1.3	
3	Handicam	1 No.
4	Television 46"	1 No.
5	Collar mike	1 No.
6	Cordless mike	1 No.
7	Audio Mixer	1 No.
8	DVD recorder/player	1 No.
9	LCD Projector with MP3/CD/DVD provision for Audio/video facility	1 No.

Evaluation:

Internal: 20 marks

Record maintenance: Students should write a report on a regular basis on the activities conducted, focusing on the details such as the description of the activity, ideas emerged, learning outcomes and so on. At the end of the semester records can be evaluated out of 20 marks.

External: 80 marks

Online Test	- 35 marks
Interview	- 15 marks
Presentation	- 15 marks
Group Discussion	- 15 marks

Note on Internal and External Evaluation:

1. Interview – mock interview can be conducted on one-on-one basis.
2. Speaking **–** example for role play:
   a. Marketing engineer convincing a customer to buy his product.
   b. Telephonic conversation- fixing an official appointment / placing an order / enquiring and so on.
3. Presentation – should be extempore on simple topics.
4. Discussion – topics of different kinds; general topics, case studies and abstract concept.

OUTCOMES:

At the end of the course, learners should be able to

- Take international examination such as IELTS and TOEFL
- Make presentations and Participate in Group Discussions.
- Successfully answer questions in interviews**.**

REFERENCES:

1. **Business English Certificate Materials,** Cambridge University Press.
2. **Graded Examinations in Spoken English and Spoken English for Work** downloadable materials from Trinity College, London.
3. **International English Language Testing System** Practice Tests, Cambridge University Press.
4. Interactive Multimedia Programs on **Managing Time and Stress.**
5. **Personality Development** (CD-ROM), Times Multimedia, Mumbai.

6. Robert M Sherfield and et al. **"Developing Soft Skills"** 4th edition, New Delhi: Pearson Education, 2009.

Web Sources:

http://www.slideshare.net/rohitjsh/presentation-on-group-discussion
http://www.washington.edu/doit/TeamN/present_tips.html
http://www.oxforddictionaries.com/words/writing-job-applications
http://www.kent.ac.uk/careers/cv/coveringletters.htm
http://www.mindtools.com/pages/article/newCDV_34.htm

PM6601 MASS TRANSFER II L T P C
3 1 0 4

OBJECTIVE:

Students will learn to design absorber and stripper, distillation column, extraction and leaching equipments and adsorber.

UNIT I ABSORPTION 9

Gas Absorption and Stripping – Equilibrium; material balance; limiting gas-liquid ratio; tray tower absorber - calculation of number of theoretical stages, tray efficiency, tower diameter; packed tower absorber – rate based approach; determination of height of packing using HTU and NTU calculations.

UNIT II DISTILLATION 9

Vapour liquid equilibria - Raoult's law, vapor-liquid equilibrium diagrams for ideal and non-ideal systems, enthalpy concentration diagrams. Principle of distillation - flash distillation, differential distillation, steam distillation, multistage continuous rectification, Number of ideal stages by Mc.Cabe - Thiele method and Ponchan - Savarit method, Total reflux, minimum reflux ratio, optimum reflux ratio. Introduction to multi-component distillation, azeotropic and extractive distillation

UNIT III LIQUID-LIQUID EXTRACTION 9

Liquid - liquid extraction - solvent characteristics-equilibrium stage wise contact calculations for batch and continuous extractors- differential contact equipment-spray, packed and mechanically agitated contactors and their design calculations-packed bed extraction with reflux. Pulsed extractors, centrifugal extractors-Supercritical extraction

UNIT IV LEACHING 9

Solid-liquid equilibria- leaching equipment for batch and continuous operations- calculation of number of stages - Leaching - Leaching by percolation through stationary solid beds, moving bed leaching, counter current multiple contact (shank's system), equipments for leaching operation, multi stage continuous cross current and counter current leaching, stage calculations, stage efficiency.

UNIT V ADSORPTION AND ION EXCHANGE & MEMBRANE SEPARATION PROCESS 9

Adsorption - Types of adsorption, nature of adsorbents, adsorption equilibria, effect of pressure and temperature on adsorption isotherms, Adsorption operations - stage wise operations, steady state moving bed and unsteady state fixed bed adsorbers, break through curves. Principle of Ion exchange, techniques and applications. Solid and liquid membranes; concept of osmosis; reverse osmosis; electro dialysis; ultrafiltration.

TOTAL (L : 45 + T : 15) : 60 PERIODS

OUTCOME:
Students will learn to design absorber and stripper, distillation column, extraction and leaching equipments and adsorber

TEXT BOOKS:
1. Wankat, P., "Equilibrium Stage Separations", Prentice Hall, 1993.
2. Treybal, R.E., "Mass Transfer Operations ", 3rd Edn., McGraw-Hill, 1981.
3. Geankoplis, C.J., "Transport Processes and Unit Operations", 4th Edition, Prentice Hall Inc., New Jersey, 2003.

REFERENCES:
1. Seader, J.D. and E.J. Henley, "Separation Process Principles", 2nd Ed., John Wiley,2006.
2. McCabe, W.L., Smith, J.C., and Harriot, P., "Unit Operations in Chemical Engineering", 7th Edn., McGraw-Hill, 2005.
3. King, C. J., "Separation Processes ", 2nd Edn.,Tata McGraw-Hill 1980.

EL6605 PROCESS DYNAMICS AND CONTROL LT P C
3 1 0 4

OBJECTIVE:
To introduce of open and closed loop systems and its responses, control loop components and stability of control systems along with instrumentation.

UNIT I INSTRUMENTATION 9
Principles of measurements and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH, concentration, electrical and thermal conductivity, humidity of gases.

UNIT II OPEN LOOP SYSTEMS 9
Laplace transformation and its application in process control. First order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics; transportation lag.

UNIT III CLOSED LOOP SYSTEMS 10
Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element, principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability.

UNIT IV FREQUENCY RESPONSE 9
Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controllers Z-N tuning rules, C-C tuning rules.

UNIT V ADVANCED CONTROL SYSTEMS 8
Introduction to advanced control systems, cascade control, feed forward control, Smith predictor, control of distillation towers and heat exchangers, introduction to computer control of chemical processes.

TOTAL : 45 PERIODS

OUTCOME:
Students will understand and discuss the importance of process control in process operation and the role of process control engineers They also Understand and design the modern hardware and instrumentation needed to implement process control.

TEXT BOOKS:

1. Stephanopoulos, G., “Chemical Process Control“, Prentice Hall of India, 2003.
2. Coughnowr, D., “ Process Systems Analysis and Control “, 3rd Edn., McGraw Hill, New York, 2008.

REFERENCES:

1. Marlin, T. E., “ Process Control “, 2nd Edn, McGraw Hill, New York, 2000.
2. Smith, C. A. and Corripio, A. B., “Principles and Practice of Automatic Process Control”, 2nd Edn., John Wiley, New York, 1997.
3. Jason L. Speyer, Walter H.Chung, ”Stochastic Processes, Estimation, and Control”,PHI Ltd (2013).

PM6603 EQUIPMENT DESIGN AND DRAWING-I L T P C
2 0 2 3

OBJECTIVE:

To develop skill to design and install process equipments used widely in a chemical industry. All Tables/ Chemical Engineers’ Handbook/Data Books/Graph Sheets are permitted during the Examination.

UNIT I DESIGN OF PIPE FITTINGS AND JOINTS 9

Design and schematic of simple bolts and screws – Riveted joints – Design and drawing of shafts and couplings.

UNIT II DESIGN OF REACTION VESSEL AND STORAGE TANK 9

Design and schematic of storage tank, (vertical and horizontal) supports, agitated vessel.

UNIT III DESIGN OF HIGH PRESSURE SYSTEMS 9

Design of high pressure vessels and reactors.

UNIT IV DESIGN OF PHASE SEPARATION EQUIPMENT 9

Design of physical separation equipments such as cyclones, centrifuges, thickeners,filtration equipment

UNIT V DRAWING OF HEAT EXCHANGERS AND COLUMNS 9

Drawing of physical process equipments such as double pipe heat exchangers – Shell and tube heat exchangers – Plate and frame heat exchangers – Distillation columns and reactors.

TOTAL : 45 PERIODS

OUTCOME:

Students skill to design and install process equipments used widely in a chemical industry.

TEXT BOOKS:

1. R.S. Khurmi, “Textbook of Machine design”. S. Chand & Company , XXV Edition , 2005.
2. M.V. Joshi and V.V. Mahajan, “Design of Process Equipment Design”, McMillan India III Edition 1994.

REFERENCES:

1. S.D. Dawande, “Process Design of Equipments”, Central Techno Publications, Nagpur, 2000.
2. Indian Standard Specifications IS-803, 1962; IS-4072, 1967; IS-2825, 1969. Indian Standards Institution, New Delhi.
3. R.H. Perry, “Chemical Engineers’ Handbook”, McGraw-Hill.
4. W.L. McCabe, J.C. Smith and P. Harriot, “Unit Operation of Chemical Engineering”, McGraw-Hill, 2001.
5. Robert Treybal, “Mass Transfer Operations”, McGraw-Hill.
6. J.M. Coulson and J.Richardson, “Chemical Engineering”, Vol. 6, Asian Books Printers Ltd.

7. Suresh C.Maidargi ,"Chemical Process Equipment Design & Drawing,Vol 1,PHI Learning Ltd (2012).

PC6606 PETROLEUM CRUDE PROCESSING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:
To learn the testing of petroleum products, crude processing and treatment techniques

UNIT I GENERAL 9
Origin – Exploration and production of petroleum – Types of crudes, crude composition – Characteristics and classification – Crude oil properties – Indigenous and imported crudes – Crude availability Vs demands.

UNIT II TESTING OF PETROLEUM PRODUCTS 9
IS 1448: Standard – Testing of Petroleum crude – Products: Specifications and their Significance.

UNIT III CRUDE PROCESSING 9
Pretreatment of crude for Refining – Dehydration and desalting – Atmospheric distillation, Vacuum distillation of residue products – Types of trays, flow pattern in the trays – Reflux types and its significance.

UNIT IV LUBE DISTILLATE TREATMENT TECHNIQUES 9
Treatment techniques for vacuum distillates with different processes like solvent extraction – Deasphalting, dewaxing, hydrofining, catalytic dewaxing and clay contact process – Production of lubricating oils.

UNIT V BITUMEN PROCESSING and FINAL TREATMENT TECHNIQUES 9
Asphalt manufacture, Air blowing technology, Bitumen Types and their properties, Acid gas removal and sulphur removal techniques.

TOTAL : 45 PERIODS

OUTCOME:
Students able to understand the principles of crude processing and various treatment techniques.

TEXT BOOKS:
1. Ram Prasad, "Petroleum Refining Technology", Khanna Publishers. .
2. Bhaskara Rao, B.K., "Modern Petroleum Refining Processes", 3rd edition, Oxford and IBH Publishing Company Pvt. Ltd.

REFERENCES:
1. James H. Gary and Glenn E. Handwerk., "Petroleum Refining Technology and Economics", 4th Edition, Marcel Dekker Inc., 2001.
2. Nelson, W.L., "Petroleum Refinery Engineering", McGraw Hill Publishing Company Limited, 1985.
3. Hobson, G.D., "Modern Petroleum Refining Technology ", 5th Edition, John Wiley Publishers, 1984

PM6604 WATER TREATMENT AND MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

To focus on the wastewater transport system and the theory and design technique for the wastewater treatment process.

UNIT I INTERNAL TREATMENT PROCESS 9

Character and properties – Water problem and solution – Water Sedimentation - Coagulation – Filtration – Disinfection – Theory, necessity, process, equipment, application, location, limitation.

UNIT II EXTERNAL TREATMENT PROCESS 9

Softening by Ion – exchange process, Demineralization – Cation exchange materials – Removal of ion, Manganese, odour, colour taste – Deaeration – Oxidation – Fluoridation – Dealkalisation – Desalination by Reverse osmosis.

UNIT III BOILER WATER AND COOLING WATER 9

Concept – Importance – Location – Commonly used desalination process – Distillation – Electrodialysis – Reverse osmosis – Freezing – Solar distillation- Purpose – Problem associated with water quality and equipment – Steam system fundamentals – Hot water closed system – Measurement and control of pH, corrosion, fouling – Microbial analysis – Ozone control – Study of microorganism – Energy efficient operations and maintenance.

UNIT IV WASTE WATER TREATMENT 9

Waste water in Industry- Home and Agriculture – Various waste water treatment processes – Optimization – Benefits and costs – Microbial and sanitation water treatment – Biofilm formation and removal – Microbial trend analysis – Pretreatment system and equipment.

UNIT V WATER MANAGEMENT IN INDIA 9

Water resources and planning – Water policy – Indian scene – Main aspects of water management – Hydrological cycle – Hydrosphere – Water transport – Water exchange – Causes and problems in irrigation, rural water, urban water – Water conservation resource management – Rain Harvesting.

TOTAL : 45 PERIODS

OUTCOME:

The students would have learnt the physical/chemical/biological characteristics and evaluation technique for sewage. They would understand the theory, engineering application, and design technique for the wastewater treatment unit process

TEXT BOOKS:

1. P.C.Bansil "Water Management in India", Concept Publishing company, New Delhi, First Edition, 2004.
2. G.S.Bridie and J.S.Bridie "Water Supply and Sanitary Engineering", Dhanpat Raj Publishing company (P) Ltd., New Delhi, 7th Edition, 2003.

REFERENCES:

1. Austin G.T., "Shreve's Chemical Process Industries", Fifth Edition, McGraw Hill, 1998.
2. S.C. Rangwala, "Water supply and Sanitary Engineering", Eighteenth Edition,Charotar Publishing House, 2003.
3. Pandey G.N., "Text Book of Chemical Technology", Vikas Publishing House Pvt. Ltd., New Delhi, 1992

PM6605 INSTRUMENTATION AND INSTRUMENTAL ANALYSIS L T P C
3 0 0 3

OBJECTIVE:
To understand the working principles of different instruments, and its applications.

UNIT I INTRODUCTION TO INSTRUMENTS, CHARACTERISTICS AND SIGNAL CONDITIONING 9

Introduction to Instruments and Their representation: Introduction, Elements, Classification, Standards, Calibration procedures Static and Dynamic Characteristics of Instruments, Specification of static characteristics, Selection of instruments, Forcing functions, Formulation of First order and second order system equations, Dynamic response Principals of Analog signal conditioning, converters, guidelines for analog signal conditioning design , Principles of digital signal conditioning, computer interface, DACs, ADCs, DAS hardware, DAS software, characteristics of digital data

UNIT II TEMPERATURE, PRESSURE, LEVEL MEASUREMENTS 9

Temperature measurement: Temperature scales, Non electrical methods, Electrical methods, Radiation methods

Pressure measurement: Moderate pressure measurement, High pressure measurement, vacuum measurement

Level measurement: measurement techniques for Liquids and slurries, advance measurement techniques

UNIT III FLOW MEASUREMENTS AND STUDY OF VALVES 9

Flow measurement: Introduction, Review of Venturimeter, orifice meters, rotameters, Pitot tube, working of turbine, vortex shedding, electromagnetic flow meters

Introduction to Advanced flow measurement techniques: Hot Wire anemometer, Laser Doppler anemometer, Ultrasound, Particle image Velocimetry

Study of Valves: Types of Valves, Actuators, Positioners, Valve characteristics, Controllability and Rangeability, Cavitation, Flashing, choking, Valve Sizing for incompressible fluids, compressible fluids, Two phase flows

UNIT IV INTRODUCTION TO QUALITY CONTROL AND ANALYTICAL TECHNIQUES 9

Need for Chemical analysis in Petroleum industry. Crude Assay. Standard Test Methods. Introduction to principles of Analytical techniques: Spectroscopic Techniques, Chromatographic techniques, Crystallography, electrochemical analysis, thermal analysis, electrophoresis, calorimetery, Hybrid techniques

Miscellaneous measurements and analysis: density, viscosity, Refractormeter, pH and redox potential measurements. Thermal conductivity gas analyzers. Oxygen determination. Orsat analysis

UNIT V WORKING AND INTERPRETATION OF INSTRUMENTAL ANALYTICAL METHODS : I 9

Spectroscopic techniques: Atomic Absorption, X-ray, inductively coupled argon plasma (ICAP), ultraviolet – visible (UV-VIS), fluorescence, infrared (IR), Raman spectroscopy, mass

spectrometry (MS),nuclear magnetic resonance (NMR)

Chromatographic Techniques: gas chromatography (GC), high pressure liquid chromatography, gel permeation chromatograpghy (GPC) , thin layer chromatograpghy (TLC), super criticle fluid chromatography (SFC)

Classification of spectroscopic and chromatographic techniques for Analysis of fuels

Working and Interpretation of Instrumental analytical methods: II

Lubricant Analysis: constituents of lubricants, characterization of lubricants by analytical techniques, importance of elemental analysis in lubricants

TOTAL : 45 PERIODS

OUTCOME:

Students gain an knowledge about the Qualitative and quantitative instrument analysis of different materials.

TEXT BOOKS:

1. Eckman, D. P.; Industrial Instrumentation; Wiley Eastern, 1991.
2. Johnson, C.; Process Control Instrumentation Technology; 4th ed., Prentice-Hall International.
3. Liptak, B. G., Venczel, K.; Instrument Engineer's Handbook, Process Measurement; Chiltan Book Company

REFERENCES:

1. Nakra, B. C.; Chaudhary K. K.; Instrumentation Measurement and Analysis; Tata McGraw Hill, New Delhi, 1998.
2. Patranabis, D.; Principles of Industrial Instrumentation; Tata McGraw Hill, New Delhi, 1996.
3. Silverstein, Bassler, Morrill; Spectrometric Identification of Organic Compounds; John Wiley Publication, 1991.
4. Gary J.H. and Handework G.E., "Petroleum Refining Technology and Economics", Marcel Dekker, Inc., 1984.

PM6611 MASS TRANSFER LABORATORY L T P C

0 0 3 2

OBJECTIVE:

Students develop a sound working knowledge on different types of mass transfer equipments.

LIST OF EXPERIMENTS

1. Separation of binary mixture using Simple distillation
2. Separation of binary mixture using Steam distillation
3. Separation of binary mixture using Packed column distillation
4. Measurement of diffusivity
5. Liquid-liquid extraction
6. Drying characteristics of Vacuum Dryer
7. Drying characteristics of Tray dryer
8. Drying characteristics of Rotary dryer
9. Water purification using ion exchange columns
10. Mass transfer characteristics of Rotating disc contactor
11. Estimation of mass/heat transfer coefficient for cooling tower
12. Demonstration of Gas – Liquid absorption

TOTAL : 45 PERIODS

OUTCOME:
Students will impart knowledge on the determination of important data for the design and operation of the process equipment's like distillation, extraction, diffusivity, drying principles which are having wide applications in various industries

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1. Simple distillation setup
2. Steam distillation setup
3. Packed column
4. Liquid-liquid extractor
5. Vacuum Dryer
6. Tray dryer
7. Rotary dryer
8. Ion exchange column
9. Rotating disc contactor
10. Cooling tower
11. Absorption column

Minimum 10 experiments shall be offered.

PM6612	**PETROLEUM PHYSICAL PROPERTIES TESTING LABORATORY**	**L T P C 0 0 3 2**

OBJECTIVE:
Students learn the determination of flash point, cloud point, smoke point, viscosity etc.

LIST OF EXPERIMENTS
1) Determination of flash point using Abel's Flash Point Apparatus.
2) Determination of flash point using Pensky Marten Flash Point Apparatus.
3) Determination of viscosity using Red Wood Viscometer
4) Determination of viscosity using Engler Viscometer.
5) Determination of viscosity using Saybolt Viscometer.
6) Determination of Cloud and Pour Point
7) Determination of Smoke Point
8) Penetration Test
9) Copper Strip Corrosion Test
10) Junker's Gas Calorimeter

TOTAL : 45 PERIODS

OUTCOME:
Students gain the practical knowledge on different petroleum testing methods

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS
1. Abel's Flash Point Apparatus
2. Pensky Marten Flash Point Apparatus.
3. Pensky Marten Flash Point Apparatus
4. Red Wood Viscometer
5. Engler Viscometer.
6. Saybolt Viscometer.
7. Junker's Gas Calorimeter

PC6712	**CHEMICAL REACTION ENGINEERING LABORATORY**	**L T P C 0 0 3 2**

OBJECTIVE:

To gain knowledge in the design of reactors.

LIST OF EXPERIMENTS

1. Kinetic studies in a Batch reactor
2. Kinetic studies in a Plug flow reactor
3. Kinetic studies in a CSTR
4. Kinetic studies in a Packed bed reactor
5. Kinetic studies in a PFR followed by a CSTR
6. RTD studies in a PFR
7. RTD studies in a Packed bed reactor
8. RTD studies in a CSTR
9. Studies on micellar catalysis
10. Study of temperature dependence of rate constant using CSTR.
11. Kinetic studies in Sono chemical reactor
12. Batch reactive distillation
13. Kinetics of photochemical reaction
14. Demonstration of heterogeneous catalytic reaction
15. Demonstration of gas-liquid reaction

TOTAL : 45 PERIODS

OUTCOME:

Students develop a sound working knowledge on different types of reactors.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Batch Reactor
2. Plug flow reactor
3. CSTR
4. Sono-chemical reactor
5. Photochemical reactor
6. Packed bed reactor

*Minimum 10 experiments shall be offered.

CH6702 TRANSPORT PHENOMENA L T P C
3 0 0 3

OBJECTIVE:

Different types of Fluids, their flow characteristics and different mathematical models are analysed and applied to actual situations. This subject helps the students to understand the mechanism of fluids in motion under different conditions.

UNIT I TRANSPORT PHENOMENA BY MOLECULAR MOTION 9

Importance of transport phenomena; analogous nature of transfer process; basic concepts, conservation laws; continuous concept, field, reference frames, substantial derivative and boundary conditions; methods of analysis; differential, integral and experimental methods.
Phenomenological laws of transport properties Newtonian and non Newtonian fluids; rheological models; theories of transport properties of gases and liquids; effect of pressure and temperature.

UNIT II ONE DIMENSIONAL TRANSPORT IN LAMINAR FLOW (SHELL BALANCE) 12

General method of shell balance approach to transfer problems; Choosing the shape of the shell; most common boundary conditions; momentum flux and velocity distribution for flow of Newtonian and non-Newtonian fluids in pipes for flow of Newtonian fluids in planes, slits and annulus heat flux and temperature distribution for heat sources such as electrical, nuclear viscous and chemical; forced and free convection; mass flux and concentration profile for diffusion in stagnant gas, systems involving reaction and forced convection.

UNIT III EQUATIONS OF CHANGE AND THEIR APPLICATIONS 14

Conservation laws and equations of change; Development of equations of continuity motion and energy in single multicomponents systems in rectangular co-ordinates and the forms in curvilinear co-ordinates; simplified forms of equations for special cases, solutions of momentum mass and heat transfer problems discussed under shell balance by applications of equation of change, scale factors; applications in scale-up

UNIT IV TRANSPORT IN TURBULENT AND BOUNDARY LAYER FLOW 6

Turbulents phenomena; phenomenological relations for transfer fluxes; time smoothed equations of change and their applications for turbulent flow in pipes; boundary layer theory; laminar and turbulent hydrodynamics thermal and concentration boundary layer and their thicknesses; analysis of flow overflat surface.

UNIT V ANALOGIES BETWEEN TRANSPORT PROCESSES 4

Importance of analogy; development and applications of analogies between momentum and mass transfer; Reynolds, Prandtl, Von Karman and Colbum analogies.

TOTAL : 45 PERIODS

OUTCOME:

Students gain the knowledge of fundamental connections between the conservation laws in heat, mass, and momentum in terms of vector and tensor fluxes.

TEXT BOOKS:

1. R.B. Bird, W.E. Stewart and E.W. Lightfoot, “Transport Phenomena”, John Wiley, II Edition 2006.
2. Robert, S Brodkey, Harry C. Hershey, “Transport Phenomena A Unified Approach ”, Brodkey Publishing 2003.

REFERENCES:

1. L.S.Sissom, and D.R.Pitts, “Elements of Transport Phenomena”, McGraw-Hill, New York, 1972.
2. R.W.Fahien, “Elementary Transport Phenomena”, McGraw-Hill, New York, 1983.
3. J.R. Welty, R.W. Wilson, and C.W.Wicks, Rorer G.E, Wilson R.W. “Fundamentals of Momentum Heat and Mass Transfer”, V Edn. John Wiley, New York, 2007.

PM6701 EQUIPMENT DESIGN AND DRAWING II L T P C

2 0 2 4

(All Tables/Chemical Engineers’ Handbook/Data Books/Graph Sheets are permitted during the Examination.)

AIM

To gain practical knowledge on the shape and drawing of the process equipments

OBJECTIVE:

To become a design engineers on process equipments design and drawing

consideration of the following:-

UNIT I THERMODYNAMIC PROPERTIES EVALUATION FOR DESIGN 9

Physical properties evaluation, Thermodynamic properties of gases and binary mixtures– Methods of calculations –Vapor-liquid equilibrium data for ideal and non-ideal mixtures. Bubble points and dew points, flash distillation calculation.

UNIT II HEAT EXCHANGER DESIGN 9

Design of double pipe heat exchangers, Heat exchanger types and its selection – shell and tube heat exchangers and Condensers – Effectiveness – NTU method of heat exchanger analysis.

UNIT III EVAPORATOR DESIGN 9

Steam – Uses of steam – Outstanding qualities of steam – BPE – Duhring's rule –Principle of multiple effect evaporation – Temperature driving force – Evaporators types and its selection – Design of single and multiple effect evaporators.

UNIT IV COLUMN DESIGN 9

Design of distillation columns and Absorption columns.

UNIT V PUMPS, FANS AND COMPRESSORS 9

Pumps, fans and compressors – Types and its applications – Characteristics – Piping and pressure drop calculations – Performance analysis of pumps, fans and compressors.

TOTAL : 45 PERIODS

OUTCOME:

Students gain the knowledge to develop key concepts and techniques to design, process equipment in a process plant. These key concepts can be utilized to make design and operating decisions.

TEXT BOOKS:

1. Ernest E. Ludwig., "Applied Process Design for Chemical and Petrochemical Plants", Vol.I, II and III, Gulf Professional Publishing, 2002.
2. D. Q. Kern, "Process Heat Transfer", Tata McGraw Hill Publishing Co., New Delhi, 1990.

REFERENCES:

1. Coulson, M. and Richardson, J.F., "Chemical Engineering", Vol.6, 3rd Edition, Pergamon Press, 1987.
2. Robert H. Perry and Don W. Green, "Perry's Chemical Engineer's Hand Book", 7th Edition, Mc Graw Hill – International, 1997.
3. Van Winkle, "Distillation Operations", McGraw Hill Publications, 1987.

PM6702 PETROLEUM SECONDARY PROCESSING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

Students learn the refining operations like cracking, reforming, alklylation, isomerization and coking

UNIT I CRACKING 9

Need and significance, types and functions of Secondary Processing. Cracking, Thermal Cracking and Visbreaking. Different Feed Stocks, Products Yields, Qualities and Recent Development. Catalytic Cracking, Commercial Catalyst, Feedstock and Catalytic Cracking Conditions, Types and Processes- Fixed Bed Cracker, Fluid Catalytic Cracking (FCC), Flexi Cracking.

UNIT II CATALYTIC REFORMING 9

Theory, Reaction Conditions and Catalyst for Catalytic Reforming, Platforming, Houdri Forming, Rhein Forming, Power Forming, Selecto Forming. Ultra Forming and Rex Forming. Naphtha Cracking, Feedstock Selection and Effect of Steam.

UNIT III ALKYLATION AND ISOMERIZATION 9

Feed Stocks and Reactions for Alkylation Process- Cascade Sulphuric Acid Alkylation,Hydrofluoric Acid Alkylation. Isomerization Process- Isomerization with Platinum Catalyst and Aluminium Chloride Process.

UNIT IV COKING 9

Methods of Petroleum Coke Production – Koppers, Thermal Cracking, Delayed Coking, Fluid Coking and Contact Coking. Hydro Cracking- principles, reactions in Hydro Cracking, Catalyst, Hydro Cracking Reaction Conditions, Iso Max Processes and Hydro Desulphurization Processes.

UNIT V ASPHALT TECHNOLOGY 9

Source of Asphalt (Bitumen), Chemical Structure of Asphalt, Action of Heat on Asphalt, Types of Asphalts. Air Blowing of Bitumen and Upgradarion of Heavy Crudes. Specialty Products:Industrial Grease- Manufacture of Calcium Grease, Liquid Paraffin and Petroleum Jellys.

TOTAL : 45 PERIODS

OUTCOME:

Student attain the detailed knowledge on petroleum refining operations.

TEXT BOOKS:

1. Jones, D.S.J. and Pujadó, P.R., Handbook of petroleum processing, Springer, The Netherlands, 2006
2. Nelson, W. L “Petroleum Refinery Engineering”, McGraw Hill Publishing Company Limited,1985.
3. Watkins, R. N “Petroleum Refinery Distillations”, 2nd Edition, Gulf Publishing Company,Texas, 1981.

REFERENCES:

1. Parkash, S., Refining processes handbook, Gulf Professional Publishing, 2003
2. Hobson, G. D “Modern Petroleum Refining Technology”, 4th Edition, Institute of Petroleum,U. K. 1973.

PM6703 PETROCHEMICAL UNIT PROCESSES L T P C
3 0 0 3

OBJECTIVE:

To design and conduct experiments and analyze and interpret data related to petrochemical Unit processes

UNIT I FEED STOCK AND SOURCE OF PETROCHEMICALS 9

Overview of Petrochemical Industry – The key growth area of India, Economics – Feed stock selections for Petrochemicals – Steam cracking of Gas and Naphtha to produce Olefins,Diolefins and Production of Acetylene – Cracker product separation and BTX separation.

UNIT II SYNTHESIS GAS PRODUCTION 9

Steam reforming of Natural gas – Naphtha and Heavy distillate to produce Hydrogen and Synthesis gas – Production of Methanol – Oxo process.

UNIT III UNIT PROCESSES I 9

Fundamental and Technological principled involved in Alkylation – Oxidation – Nitration and Hydrolysis.

UNIT IV UNIT PROCESSES II 9

Fundamental and Technological principled involved in Sulphonation, Sulfation and Isomerisation.

UNIT V UNIT PROCESSES III 9

Fundamental and Technological principles involved in Halogenation and Esterification

TOTAL : 45 PERIODS

OUTCOME:

Students able to understand the principles of various unit processes in the petrochemical industry.

TEXT BOOKS:

1. Bhaskara Rao, B.K., “A Text on Petrochemicals”, Khanna Publishers, 2000.
2. Sukumar Maiti, “Introduction to Petrochemicals”, 2nd Edition, Oxford and IBH Publishers, 2002.

REFERENCES:

1. Margaret Wells, “Handbook of Petrochemicals and Processes”, 2nd Edition, Ash Gate Publishing Limited, 2002.
2. Sami Matar, and Lewis F. Hatch., “Chemistry of Petrochemical Processes”, 2nd Edition, Gulf Publishing Company, 2000.
3. Dryden, C.E., “Outlines of Chemical Technology”, 2nd Edition, Affiliated East-West Press, 1993.

PM6704 REFINERY PROCESS DESIGN L T P C
3 0 0 3

OBJECTIVE:

To get acquainted with process design of distillation columns involving multicomponent and complex mixtures. To learn methodologies practiced in rating and designing heat transfer equipment used in refining and process industry.

UNIT I MULTICOMPONENT DISTILLATION 9

Dew point and bubble point for multi component mixtures. Design of multi component distillation column, Number of variables, Selection of key components, Selection of column pressure, Feed condition, Plate-to-plate calculations, Empirical short cut methods, Introduction to rigorous solution procedures.

UNIT II PETROLEUM REFINERY DISTILLATION 9

TBP, EFV, ASTM distillation curves and their relevance, Material balance and flash zone

calculations for petroleum refinery distillation columns, Pump around and pump back calculations, Overall energy requirements, Estimation of number of equilibrium stages, Design using Packie charts and Watkins method, Introduction to rigorous solution procedure based on pseudo components.

UNIT III COLUMN DESIGN 9

Process design of distillation towers. Flooding charts. Trays and packings. Vacuum devices.Pressure drops. Height,diameter,supports.Piping requirements. Aspects of mechanical design. A typical P&ID for a distillation column. .

UNIT IV FIRED HEATERS 9

Heat load calculations for furnace heaters used in crude refining, Basic constructional features, Different furnace types, Review of factors to be considered in the design of fired heaters, Introduction to manual calculations methods.

UNIT V PUMPS AND COMPRESSORS 9

Types of pumps and compressors. Selection criteria. Power rating calculations based on process duty.Use of operating curves of centrifugal pump. NPSHR and NPSHA. Pump Cavitation. Surge problem in compressors.

TOTAL : 45 PERIODS

OUTCOME:

Students learn process design aspects related to distillation column, Fired Heaters, pumps and compressors

TEXT BOOKS:

1. Van Winkle M., “Distillation”, McGraw Hill, 1967.
2. Watkins, “Petroleum Refinery Distillation”, McGraw Hill, 1993
3. Sinnott R. K., “Coulson and Richardson’s Chemical engineering”, Vol. 6, Third Edition, Butter Worth-Heinemann, 1999.
4. Kern D. Q., “Process Heat Transfer”, McGraw Hill, 1965.
5. Cao Eduardo,”Heat Transfer in Process Engineering”, McGraw Hill,2010

EL6713 PROCESS DYNAMICS AND CONTROL LABORATORY L T P C

0 0 3 2

OBJECTIVE:

To train the students to determine experimentally the methods of controlling the processes including measurements using process simulation techniques.

LIST OF EXPERIMENTS

1. Response of first order system
2. Response of second order system
3. Response of Non-Interacting level System
4. Response of Interacting level System
5. Open loop study on a thermal system
6. Closed loop study on a level system
7. Closed loop study on a flow system
8. Closed loop study on a thermal system
9. Tuning of a level system
10. Tuning of a pressure system
11. Tuning of a thermal system
12. Flow co-efficient of control valves

13. Characteristics of different types of control valves
14. Closed loop study on a pressure system
15. Tuning of pressure system
16. Closed loop response of cascade control system

*Minimum 10 experiments shall be Offered.

TOTAL : 45 PERIODS

OUTCOME:

Upon completion of this practical course, the students would know development and use of right type of control dynamics for process control under different operative conditions.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. U tube manometer with controller
2. Interacting Tank
3. Non Interacting Tank
4. Open loop control system
5. Closed loop control system
6. ON/OFF controller
7. Control valve characteristics
8. Pressure Tuner
9. Temperature Tuner
10. Proportional Controller
11. Flow Transmitter
12. Level Transmitter
13. Cascade control system

PM6711 PETROCHEMICAL ANALYSIS LABORATORY L T P C

0 0 3 2

OBJECTIVE:

To learn basic principles involved in analysis of petrochemical products.

LIST OF EXPERIMENTS

1. Sulphur content determination
2. Flue gas Analysis – Orsat Apparatus
3. Aromatic Content determination
4. Hydrogen sulphide content determination
5. Mercaptan as sulphur estimation apparatus
6. Determination of Lead, Acid and Salt content
7. separation from lubricating Grease (Oil Separation Apparatus)
8. Analysis of petrochemicals using UV spectrophotometer
9. Analysis of petrochemicals using NMR with MS
10. Analysis of petrochemicals using Gas chromatography
11. Biodegradation of petrochemicals
12. Bioremediation of petrochemicals
13. Refractive index of petrochemicals
14. Determination of moisture content – KF titrator
15. Total acidity determination

TOTAL : 45 PERIODS

OUTCOME:

Students would have knowledge about characterization of oil and lubricants and apply their knowledge in industries.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Bomb calorimeter
2. Orsat apparatus
3. Aniline point apparatus
4. UV- Visible spectrophotometer.
5. Gas Chromatography.

PC6711 PETROLEUM PRODUCT TESTING LABORATORY L T P C

0 0 3 2

OBJECTIVE:

To learn basic principles involved in determination of flash point, cloud point, aniline point, viscosity etc.

LIST OF EXPERIMENTS

1. Determination of aniline point and diesel index
2. Softening point of bitumen by ring and ball method
3. Ductility and penetration number of bitumen
4. Rust preventing characteristics of lube oil
5. Drop point of greases
6. Cloud and pour point determination
7. Smoke point determination
8. Copper corrosion testing of petroleum products
9. Sediment content of crude oil and fuel oils
10. Coking tendency of oil
11. Saybolt color of petroleum products / loviband tintometer
12. Water separability of petroleum products
13. Refractive index of petroleum products
14. Hydrocarbon types in petroleum products
15. Carbon residue determination
16. Oxidation stability of gasoline and ATF
17. Bearing and grease noise characteristics

TOTAL : 45 PERIODS

OUTCOME:

Students would have knowledge about the lubricants and use of right type of lubricant in different machines.

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

1. Abel's Flash point apparatus
2. Penky morten Flash point apparatus
3. Red wood viscometer
4. Sayboh viscometer
5. Cloud and pour point apparatus.

PM6801 PROCESS ENGINEERING ECONOMICS L T P C

3 0 0 3

OBJECTIVE:

The objective of this course is to teach principles of cost estimation, feasibility analysis, management, organization and quality control that will enable the students to perform as efficient managers.

UNIT I ENGINEERING FLOW DIAGRAMS AND SAFETY ASPECTS 9

Process Design Diagrams / Documents: Introduction to block, process flow, Logic, Information flow diagrams. Preparation of PID, trip and interlock systems, MOC and valve selection, color code of pipeline, Equipment datasheets, Layout engineering (Plot Plan)

Safety In Process and Plant Design: Intrinsic / extrinsic safety, Safety of personnel, equipment

and plant classification of plant areas, Fire protection systems, Flare systems, Safety relief valves, Flame arrestors, rupture disc and explosion venting etc., Health , Safety and Environmental hazards, Loss Prevention: Hazard Assessment Techniques: HAZOP, HAZAN, Fault Tree Analysis, etc

UNIT II PROJECT ENGINEERING 9

Project Management and Statutory Regulations: Site Layout, Plant Layout, Battery Limits and Off Site Facilities, Stages of project, Use of Milestone chart / GANT chart/BAR chart, PERT and CPM techniques for project monitoring and control, Preparation of project reports (Feasibility Reports), Annual report of a company.

UNIT III OVERVIEW OF PROCESS ECONOMICS 9

Economic decision making in the CPI, Process plant components, elements of costing and principles of accounting, Total cost components, Types and methods of cost estimation, Cost estimation for equipment and plant, Direct / indirect manufacturing costs.

UNIT IV MANUFACTURING COST ESTIMATION 9

Various cost indices, William's sixth tenth rule, methods of estimation of fixed capital, product cost estimation, Financing, Interest and investment cost, present worth and discount annuities, Source of capital, Depreciation, Taxes and Insurances, Balance Sheets, Perpetuity, Inflation.

UNIT V PROFITABILITY: ALTERNATIVE INVESTMENTS AND REPLACEMENTS PROFITABILITY: 9

Alternative investments and replacements, profitability standards, discounted cash flow, rate of return, capitalized cost, payment period, alternative investments, analysis with small investments, increments and replacements, Break Even Analysis.

TOTAL : 45 PERIODS

OUTCOME:

Students gain the knowledge on cost and asset accounting, time value of money, profitability, alternative investments, minimum attractive rate of return, sensitivity and risk analysis.

TEXT BOOKS:

1. M.S. Peters and K. D. Timmerhaus, "Plant Design and Economics for Chemical Engineers", Fourth Edition, McGraw Hill International Book Co., 1991
2. James R. Cooper, "Process Engineering Economics", Marcel Delkker Inc, New York, 2003
3. Coulson, J.M., Richardson J.E. and Sinnott R.K., "Chemical Engineering", Vol. VI, Pergamon Press, 1991.
4. R. Turton, R. C. Bailie, W. B. Whiting, and J. A. Shaeiwitz, " Analysis, Synthesis, and Design of Chemical Processes", Prentice Hall, Upper Saddle River, New Jersey, 1998.
5. L. S. Srinath, "PERT and CPM, Principles and Applications", Third Edition, East-West Press, 2002.

PM6802 SAFETY AND RISK MANAGEMENT L T P C

3 0 0 3

OBJECTIVE:
Students learn about implementation of safety procedures, risk analysis and assessment, hazard identification

UNIT I INDUSTRIAL SAFETY 9
Concepts of safety – Hazard classification chemical, physical, mechanical, ergonomics, biological and noise hazards – Hazards from utilities like air, water, steam.

UNIT II HAZARD IDENTIFICATION AND CONTROL 9
HAZOP, job safety analysis – Fault tree analysis – Event tree analysis – Failure modes and effect analysis and relative ranking techniques – Safety audit – Plant inspection – Past accident analysis.

UNIT III RISK MANAGEMENT 9
Overall risk analysis – Chapains model, E and FI model– Methods for determining consequences effects: Effect of fire, Effect of explosion and toxic effect – Disaster management plan – Emergency planning – Onsite and offsite emergency planning – Risk management – Gas processing complex, refinery – First aids.

UNIT IV SAFETY PROCEDURES 9
Safety in plant design and layout – Safety provisions in the factory act 1948 – Indian explosive act 1884 – ESI act 1948 – Advantages of adopting safety laws.

UNIT V SAFETY IN HANDLING AND STORAGE OF CHEMICALS 9
Safety measures in handling and storage of chemicals – Fire chemistry and its control – Personnel protection – Safety color codes of chemicals.

TOTAL : 45 PERIODS

OUTCOME:
Students get acquainted with risk assessment, process safety auditing and management systems in the petrochemical Industry

TEXT BOOKS:
1. Blake, R.P., “Industrial Safety”, Prentice Hall, 1953.
2. Lees, F.P., “Loss Prevention in Process Industries”, 2nd Edition, Butterworth Heinemann, 1996.

REFERENCES:
1. Geoff Wells, “Hazard Identification and Risk Assessment”, I.ChE.
2. John Ridley and John Channing, “Safety at Work”, 6th Edition. Butterworth-Heinemann, 2003.
3. Raghavan, K.V. and Khan, A.A., “Methodologies in Hazard Identification and Risk Assessment”, Manual by CLRI, 1990.

CH6016 PROCESS MODELLING AND SIMULATION L T P C
3 0 0 3

OBJECTIVE:
To give an overview of various methods of process modeling, different computational techniques for simulation. The focus shall be on the techniques themselves, rather than specific applications so that the student can take up modeling and simulation challenges in his profession.

UNIT I INTRODUCTION 6

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

UNIT II STEADY STATE LUMPED SYSTEMS 9

Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

UNIT III UNSTEADY STATE LUMPED SYSTEMS 9

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

UNIT IV STEADY STATE DISTRIBUTED SYSTEM 8

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER MODELLINGAPPROACHES 13

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor, hierarchy in model development, classification and solution of partial differential equations. Empirical modeling, parameter estimation, population balance and stochastic modeling.

TOTAL : 45 PERIODS

OUTCOME:

Upon completing the course, the student should have understood the development of process models based on conservation principles and process data and computational techniques to solve the process models.

TEXT BOOKS:

1. Ramirez, W.; "Computational Methods in Process Simulation ", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., " Process Modelling Simulation and Control ",2nd Edn, McGraw-Hill Book Co., 1990

REFERENCES:

1. Felder, R. M. and Rousseau, R. W., " Elementary Principles of Chemical Processes ", John Wiley, 2000.
2. Franks, R. G. E., " Mathematical Modelling in Chemical Engineering ", John Wiley, 1967.

CH6009 FERTILIZER TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques

UNIT I NITROGENOUS FERTILISERS 9

Methods of production of nitrogenous fertilizer-ammonium sulphate, nitrate, urea and calcium ammonium nitrate; ammonium chloride and their methods of production, characteristics and specifications, storage and handling.

UNIT II PHOSPHATIC FERTILISERS 9

Raw materials; phosphate rock, sulphur; pyrites etc., processes for the production of sulphuric and phosphoric acids; phosphates fertilizers - ground rock phosphate; bone meal-single superphosphate, triple superphosphate, triple superphosphate, thermal phosphates and their methods of production, characteristics and specifications.

UNIT III POTASSIC FERTILISERS 9

Methods of production of potassium chloride, potassium schoenite, their characteristics and specifications.

UNIT IV COMPLEX AND NPK FERTILISERS 9

Methods of production of ammonium phosphate, sulphate diammonium phosphate, nitrophosphates, urea, ammonium phosphate, mono-ammonium phosphate and various grades of NPK fertilizers produced in the country.

UNIT V MISCELLANEOUS FERTILISERS 9

Mixed fertilizers and granulated mixtures; biofertilisers, nutrients, secondary nutrients and micro nutrients; fluid fertilizers, controlled release fertilizers, controlled release fertilizers.

TOTAL: 45 PERIODS

OUTCOME:

Upon completion of this course, the students will be able to understand the chemical technology of various fertilizers and their methods of production, characteristics and specification.

TEXT BOOKS:

1. "Handbook of fertilizer technology", Association of India, New Delhi, 1977.
2. Menno, M.G.; "Fertilizer Industry - An Introductory Survey", Higginbothams Pvt. Ltd., 1973.

REFERENCES:

1. Sauchelli, V.; "The Chemistry and Technology of Fertilizers", ACS MONOGRAPH No. 148, Reinhold Publishing Cor. New York, 1980.
2. Fertiliser Manual, "United Nations Industrial Development Organisation", United Nations, New York, 1967.
3. Slack, A.V.; Chemistry and Technology of Fertilisers, Interscience, New York, 1966.

PC6002 PETROLEUM PROCESS EQUIPMENT AUXILIARIES L T P C
3 0 0 3

OBJECTIVE:

To give an overview of various equipment auxiliaries involved in the petroleum processes.

UNIT I ELECTRICAL MOTORS AND STARTERS 9

Electrical motors – Induction –Synchronous – Electrical Starters.

UNIT II ROTARY EQUIPMENT 9

Pumps –Turbines – Blowers – Compressors – Fans – Concept – Working and application.

UNIT III INDUSTRIAL VALVE 9

Needle valves – Globe, gate and ball valves – Butterfly valves – Check and needle valves –

Piping system.

UNIT IV INDUSTRIAL DRYERS 9

Rotary fluid bed – Spray and freeze dryers – Electrosmotic dryers – Rotary dryer – Case studies.

UNIT V PROCESS UTILITY EQUIPMENTS 9

Vacuum devices – Filters – Cooling towers – Refrigeration systems – Flare system – Equipments for waste water treatment systems.

TOTAL : 45 PERIODS

OUTCOME:

Student gain knowledge on the utility equipment's and other auxiliaries and its applications.

TEXT BOOKS:

1. Walas, S.M., "Chemical Process Equipment", Butterworth – Heinemann Oxford Publishing Ltd., 1999.
2. Thomas, C.E., "Process Technology – Equipment and systems", Uhai Publishing, Inc., 2002.

REFERENCES:

1. Ludwig, E.E., "Applied Process Design for Chemical and Petrochemical Plants", Vol.I and III, Gulf Professional Publishing, 2002.
2. Perry, R.H. and Green, D.W., "Perry's Chemical Engineer's Hand Book", 7th Edition, Mc Graw Hill – International, 1997.
3. Sahu, G.K., "Hand Book of Piping Design", New Age International Publishers, 2005

MG6091 INDUSTRIAL MANAGEMENT LT P C
3 0 0 3

OBJECTIVE:

To provide an opportunity to learn basic management concepts essential for business.

UNIT I INTRODUCTION 9

Management - Definition – Functions – Evolution of Modern Management – Scientific Management Development of Management Thought. Approaches to the study of Management, Forms of Organization – Individual Ownership – Partnership – Joint Stock Companies – Co-operative Enterprises – Public Sector Undertakings, Corporate Frame Work – Share Holders – Board of Directors – Committees – Chief Executive –Trade Union.

UNIT II FUNCTIONS OF MANAGEMENT 9

Planning – Nature and Purpose – Objectives – Strategies – Policies and Planning Premises – Decision Making – Organizing – Nature and Process – Premises – Departmentalization – Line and staff – Decentralization – Organizational culture, Staffing - selection and training – Placement – Performance appraisal – Career Strategy – Organizational Development. Leading – Managing human factor – Leadership – Communication, Controlling - Process of Controlling – Controlling techniques,
productivity and operations management – Preventive control, Industrial Safety.

UNIT III ORGANIZATIONAL BEHAVIOUR 9

Definition – Organization – Managerial Role and functions – Organizational approaches, Individual behaviour – causes – Environmental Effect – Behavior and Performance, Perception – Organizational Implications. Personality – Contributing factors - Dimension – Need Theories

– Process Theories – Job Satisfaction, Learning and Behavior – Learning Curves, Work Design and approaches.

UNIT IV GROUP DYNAMICS 9

Group Behavior – Groups – Contributing factors – Group Norms, Communication – Process – Barriers to communication – Effective communication, leadership – formal and informal characteristics – Managerial Grid – Leadership styles – Group Decision Making – Leadership Role in Group Decision, Group Conflicts – Types – Causes – Conflict Resolution – Inter group relations and conflict, Organization centralization and decentralization – Formal and informal – Organizational Structures – Organizational Change and Development – Change Process – Resistance to Change – Culture and
Ethics.

UNIT V MODERN CONCEPTS 9

Management by Objectives (MBO), Management by Exception (MBE), Strategic Management - Planning for Future direction – SWOT Analysis – Information technology in management – Decisions support system – Business Process Re-engineering (BPR) – Enterprises Resource Planning (ERP) – Supply Chain Management (SCM) – Activity Based Management (ABM).

TOTAL : 45 PERIODS

OUTCOME :

Students gain knowledge on the basic management principles to become management(s) professional.

TEXTBOOKS:

1. Herald Knottz and Heinz Weihrich, 'Essentials of Management', Tata McGraw Hill Education Pvt. Ltd., 2010.
2. Stephen P. Robbins, 'Organization Behaviour', Pearson Education Inc., 13 edition, 2010.

REFERENCES:

1. Ties, AF, Stoner and R.Edward Freeman, 'Management' Prentice Hall of India Pvt. Ltd. New Delhi 110 011, 1992
2. Joseph J, Massie, 'Essentials of Management' Prentice Hall of India Pvt. Ltd. 1985.
3. P.C. Tripathi & P.N. Reddy, 'Principles of Management', TataMcGraw Hill, 2006.

GE6757 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

OBJECTIVE :

To facilitate the understanding of Quality Management principles and process.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby - Barriers to TQM - Quality statements - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Costs of quality.

UNIT II TQM PRINCIPLES 9

Leadership - Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Quality circles Recognition and Reward, Performance

appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES I 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Control Charts - Process Capability - Concepts of Six Sigma - Quality Function Development (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors..

TOTAL: 45 PERIODS

OUTCOME:

The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

TEXTBOOK:

1. Dale H. Besterfiled, et at., "Total quality Management", Pearson Education Asia, Third Edition, Indian Reprint (2006).

REFERENCES:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
3. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

CH6002 FLUIDIZATION ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

To learn the design Aspects of Heat and mass transfer in fluidized beds.

UNIT I BASICS OF FLUIDIZATION 9

Packed bed – Velocity – Pressure drop relations – Correlations of Ergun, Kozneykarman – On set of fluidization – Properties of fluidized beds – Development of fluidization from fixed bed.

UNIT II FLUIDIZED BED TYPES 9

Minimum fluidization conditions – Expanded bed – Elutriation – Moving solids and dilute phase – spouted bed.

UNIT III DESIGN ASPECTS 9

Channeling – Bed expansion in liquid – Solid and gas – Solid fluidizations. Design aspects of fluidized bed systems.

UNIT IV HEAT AND MASS TRANSFER IN FLUIDIZED BEDS 9

Heat and mass transfer in fluidized bed systems – Industrial applications and case studies of fluidized bed systems.

UNIT V OTHER TYPES OF FLUIDIZATION 9

Single stage and multistage fluidization – Collection of fines – Use of cyclones.

TOTAL : 45 PERIODS

OUTCOME:

Students gain the knowledge on fluidization phenomenon, behavior of fluidized beds and its industrial applications.

TEXT BOOKS:

1. Levenspiel, "Fluidization Engineering", 2nd Edition, Butterworth – Heinmann, 1991.
2. Robert H. Perry and Don W. Green, "Perry's Chemical Engineer's Hand Book", 7th Edition, Mc Graw Hill – International, 1997.

REFERENCES:

1. Rowe and Davidson, "Fluidization", Academic Press ,1971.
2. Leva, M., "Fluidization", McGraw Hill Book Co, 1959.
3. Wen-Ching Yang., "Handbook of Fluidization and Fluid-Particle Systems", Marcel Dekker Inc, 2003.

PC6005 ENERGY MANAGEMENT IN CHEMICAL INDUSTRIES L T P C
3 0 0 3

OBJECTIVE:

To understand the interaction between different parts of the energy system

UNIT I ENERGY RESOURCES – A GLOBAL VIEW 9

Energy sources – Coal oil, natural gas – Nuclear energy – Hydro electricity – Other fossil fuels – Geothermal – Supply and demand – Depletion of resources of resources – Need for conservation – Uncertainties – National and international issues.

UNIT II ENERGY AND ENVIRONMENT 9

Energy – Various forms – Energy storage – Structural properties of environment – Biogeo – chemical cycles – Society and environment population and technology.

UNIT III MANAGEMENT OF ENERGY CONSERVATION IN CHEMICAL INDUSTRIES 9

Chemical industries – Classification – Conservation in unit operation such as separation – Cooling tower – Drying – Conservation applied to refineries, petrochemical, fertilizers, cement, pulp and paper, food industries – Chloroalkali industries – Conservation using optimization techniques.

UNIT IV ENERGY ALTERNATIVES 9

Sources of continuous power – Wind and water – Geothermal – Tidal and solar power – MHD, fuel cells – Hydrogen as fuel.

UNIT V ECONOMIC BALANCE IN ENERGY CONSUMPTION 9

Cost analysis – Capacity – Production rate – System rate – System cost analysis – Corporate models – Production analysis and production using fuel inventories – Input output analysis – Economics – Tariffs.

TOTAL : 45 PERIODS

OUTCOME:
Students have the ability to apply the fundamentals of energy conversion and applications.

TEXT BOOKS:
1. Krentz, J. H., "Energy Conservation and Utilisation", Allyn and Bacur Inc., 1976.
2. Gramlay, G. M., "Energy", Macmillon Publishing Co., 1975.

REFERENCES:
1. Rused C.K., "Elements of Energy Conservation", McGraw – Hill Book Co., 1985.
2. Judson King; "Separation Processes", McGraw – Hill Book Co., 1985.
3. Samir Sarkar, "Fuels and Combustion", 2nd Edition, Orient Longman Publication, 1988.

PC6004 NOVEL SEPARATION PROCESSES L T P C
3 0 0 3

OBJECTIVE :
To learn the principle and technical concept of advanced separation processes.

UNIT I BASICS OF SEPARATION PROCESS 9
Review of Conventional Processes, Recent advances in Separation Techniques based on size, surface properties, ionic properties and other special characteristics of substances,Process concept, Theory and Equipment used in cross flow Filtration, cross flow Electro Filtration, Surface based solid – liquid separations involving a second liquid.

UNIT II MEMBRANE SEPARATIONS 9
Types and choice of Membranes, Plate and Frame, tubular, spiral wound and hollow fiber Membrane Reactors and their relative merits, commercial, Pilot Plant and Laboratory Membrane permeators involving Dialysis, Reverse Osmosis, Nanofiltration, Ultra filtration and Micro filtration, Ceramic- Hybrid process and Biological Membranes.

UNIT III SEPARATION BY ADSORPTION 9
Types and choice of Adsorbents, Adsorption Techniques, Dehumidification Techniques, Affinity Chromatography and Immuno Chromatography, Recent Trends in Adsorption.

UNIT IV INORGANIC SEPARATIONS 9
Controlling factors, Applications, Types of Equipment employed for Electrophoresis, Dielectrophoresis, Ion Exchange Chromatography and Eletrodialysis, EDR, Bipolar Membranes.

UNIT V OTHER TECHNIQUES 9
Separation involving Lyophilisation, Pervaporation and Permeation Techniques for solids, liquids and gases, zone melting, Adductive Crystallization, other Separation Processes, Supercritical fluid Extraction, Oil spill Management, Industrial Effluent Treatment by Modern Techniques.

TOTAL : 45 PERIODS

OUTCOME:
Fully understand key concepts of separation processes including equilibrium stages, reflux, countercurrent contacting, limiting cases, efficiency and mass transport effects.

TEXT BOOKS:
1. Schoen, H.M., "New Chemical Engineering Separation Techniques", Interscience Publishers,1972.

2. Treybal, R.E., “Mass Transfer Operations”, 3rd Edition, McGraw Hill Book Co., 1980.

REFERENCES:

1. King, C. J., “Separation Processes”, Tata McGraw Hill, 1982.
2. Roussel, R. W., “Handbook of Separation Process Technology”, John Wiley, New York, 1987
3. Nakagawal, O. V., “Membrane Science and Technology”’ Marcel Dekkar, 1992.

PC6006 MULTICOMPONENT DISTILLATION L T P C
3 0 0 3

OBJECTIVE:

To understand the concepts of Multicomponent distillation systems.

UNIT I THERMODYNAMIC PRINCIPLES 9

Fundamental Thermodynamic principles involved in the calculation of vapor – liquid equilibria and enthalpies of multi component mixtures – Use of multiple equation of state for the calculation of K values – Estimation of the fugacity coefficients for the vapor phase of polar gas mixtures – calculation of liquid – phase activity coefficients.

UNIT II THERMODYNAMIC PROPERTY EVALUATION 9

Fundamental principles involved in the separation of multi component mixtures – Determination of bubble-point and Dew Point Temperatures for multi component mixtures – equilibrium flash distillation calculations for multi component mixtures – separation of multi component mixtures at total reflux.

UNIT III MINIMUM REFLUX RATIO FOR MCD SYSTEM 9

General considerations in the design of columns – Column sequencing – Heuristics for column sequencing – Key components – Distributed components – Non-Distributed components – Adjacent keys. Definition of minimum reflux ratio – calculation of Rm for multi component distillation – Underwood method – Colburn method.

UNIT IV VARIOUS METHODS OF MCD COLUMN DESIGN 9

Theta method of convergence – Kb method and the constant composition method – Application of the Theta method to complex columns and to system of columns – Lewis Matheson method –Stage and reflux requirements – Short cut methods and Simplified graphical procedures.

UNIT V VARIOUS TYPES OF MCD COLUMNS 9

Design of sieve, bubble cap, valve trays and structured packing columns for multi component distillation – computation of plate efficiencies.

TOTAL : 45 PERIODS

OUTCOME:

Students able to design multicomponent distillation unit. They learn about various types of MCD column.

TEXT BOOKS:

1. Holland, C.D., “Fundamentals of Multi Component Distillation”, McGraw Hill Book Company, 1981
2. Van Winkle, “Distillation Operations”, McGraw Hill Publications, 1987.

REFERENCES:

1. King, C.J., “Separation Process Principles”, Mc Graw Publications, 1986.
2. Treybal, R.E., “Mass Ttransfer Operations”, 5th Edition, Mc Graw Hill publications.

1996.
3. Mc Cabe and Smith, J.C., Harriot, “Unit Operation of Chemical Engineering”, 6th Edition, McGraw Hill, 2001.

PC6008 **POLYMER TECHNOLOGY** **L T P C**
3 0 0 3

OBJECTIVE:
Understand to compute molecular weight averages from the molecular weight distribution, Condensation polymerization and transition in polymers.

UNIT I INTRODUCTION 6
History of Macromolecules – structure of natural products like cellulose, rubber,proteins – concepts of macro molecules – Staudinger's theory of macromolecules – difference between simple organic molecules and macromolecules.

UNIT II ADDITION POLYMERIZATION 12
Chemistry of Olefins and Dienes – double bonds – Chemistry of free radicals – monomers – functionality – Polymerization: Initiation – types of initiation – free radical polymerization – cationic polymerization – anionic polymerization – coordination polymerization – industrial polymerization – bulk, emulsion, suspension and solution polymerization techniques – Kinetics – Copolymerization concepts.

UNIT III CONDENSATION POLYMERIZATION 9
Simple condensation reactions – Extension of condensation reactions to polymer synthesis – functional group reactivity – polycondensation – kinetics of polycondensation-Carother's equation – Linear polymers by polycondensation – Interfacial polymerization – crosslinked polymers by condensation – gel point.

UNIT IV MOLECULAR WEIGHTS OF POLYMERS 9
Difference in molecular weights between simple molecules and polymers – number average and weight average molecular weights – Degree of polymerization and molecular weight – molecular weight distribution – Polydispersity – molecular weight determination. Different methods – Gel Permeation Chromatography – Osmometry, Light Scattering.

UNIT V TRANSITIONS IN POLYMERS 9
First and second order transitions – Glass transition, Tg – multiple transitions in polymers – experimental study – significance of transition temperatures – crystallinity in polymers – effect of crystallization – in polymers – factors affecting crystallization crystal nucleation and growth – relationship between Tg and Tm – Relationship between properties and crystalline structure.

TOTAL : 45 PERIODS

OUTCOME:
Student should be able to demonstrate knowledge and understanding the principles related to the synthesis and characterization of polymers.

TEXTBOOKS:

1. Billmeyer.F.W.,Jr, Text Book of Polymer Science, Ed. Wiley-Interscience, 1984.
2. Seymour.R.B., and Carraher.C.E., Jr., Polymer Chemistry, 2nd Ed., Marcel Dekker, 1988.
3. Gowariker.V.T., Viswanathan.N.V., and Sreedar.J., Polymer Science, Wiley Eastern Ltd., 1988.

REFERENCES:

1. Joel,R.F; Polymer Science and Technology, Eastern Economy Edition, 1999.
2. Rodriguez, F., Cohen.C., Oberic.K and Arches, L.A., Principles of Polymer Systems, 5th edition, Taylor an